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Noda

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(54) **THERMAL DETECTOR, THERMAL DETECTION DEVICE, AND ELECTRONIC INSTRUMENT**

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G01J 5/00 (2006.01)
G01J 5/08 (2006.01)
G01J 5/20 (2006.01)

(52) **U.S. Cl.**

CPC ***G01J 5/0025*** (2013.01); ***G01J 5/023*** (2013.01); ***G01J 5/024*** (2013.01); ***G01J 5/0235*** (2013.01); ***G01J 5/0896*** (2013.01); ***G01J 5/20*** (2013.01)

(58) **Field of Classification Search**

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USPC 374/120, 121, 141, 163, 178; 250/338.1, 338.3, 338.4; 438/57

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,397,897	A *	3/1995	Komatsu et al.	250/338.4
5,698,852	A	12/1997	Tanaka et al.	
6,034,374	A	3/2000	Kimura et al.	
6,211,527	B1 *	4/2001	Chandler	250/492.2
6,249,001	B1 *	6/2001	Sauer et al.	250/338.1
6,750,452	B1	6/2004	Morita	
6,818,892	B1 *	11/2004	Etienne et al.	250/338.3
7,579,663	B2 *	8/2009	Wan	257/415

(Continued)

FOREIGN PATENT DOCUMENTS

EP	0827216	A2	3/1998
JP	08-297053	A	11/1996

(Continued)

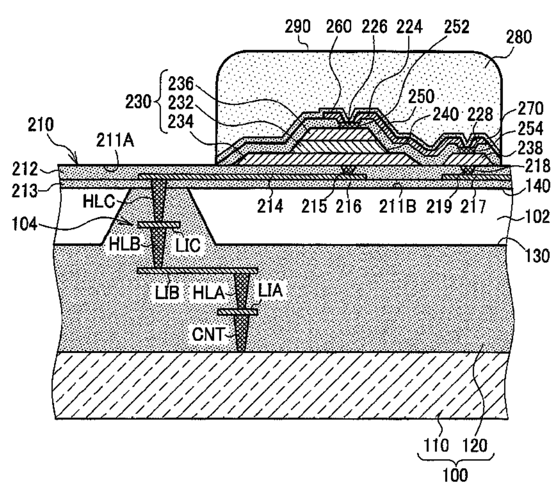
Primary Examiner — Gail Kaplan Verbitsky

(74) *Attorney, Agent, or Firm* — Global IP Counselors, LLP

(57) **ABSTRACT**

A thermal detector includes a substrate, a support member, a spacer member, a thermal detection element, a detection circuit and a wiring part. The spacer member supports the support member over the substrate with a cavity part being formed therebetween. The thermal detection element is supported on the support member. The wiring part connects between the detection circuit and the thermal detection element, and has first through third conductive layer parts and a plurality of plugs. The first conductive layer part includes at least one layer disposed in the substrate. The second conductive layer part includes at least one layer disposed in the spacer member. The third conductive layer part includes at least one layer supported by the support member. The plugs respectively connect adjacent layers of the first conductive layer part, the second conductive layer part and the third conductive layer part, in a thickness direction of the substrate.

20 Claims, 12 Drawing Sheets



(56) **References Cited**

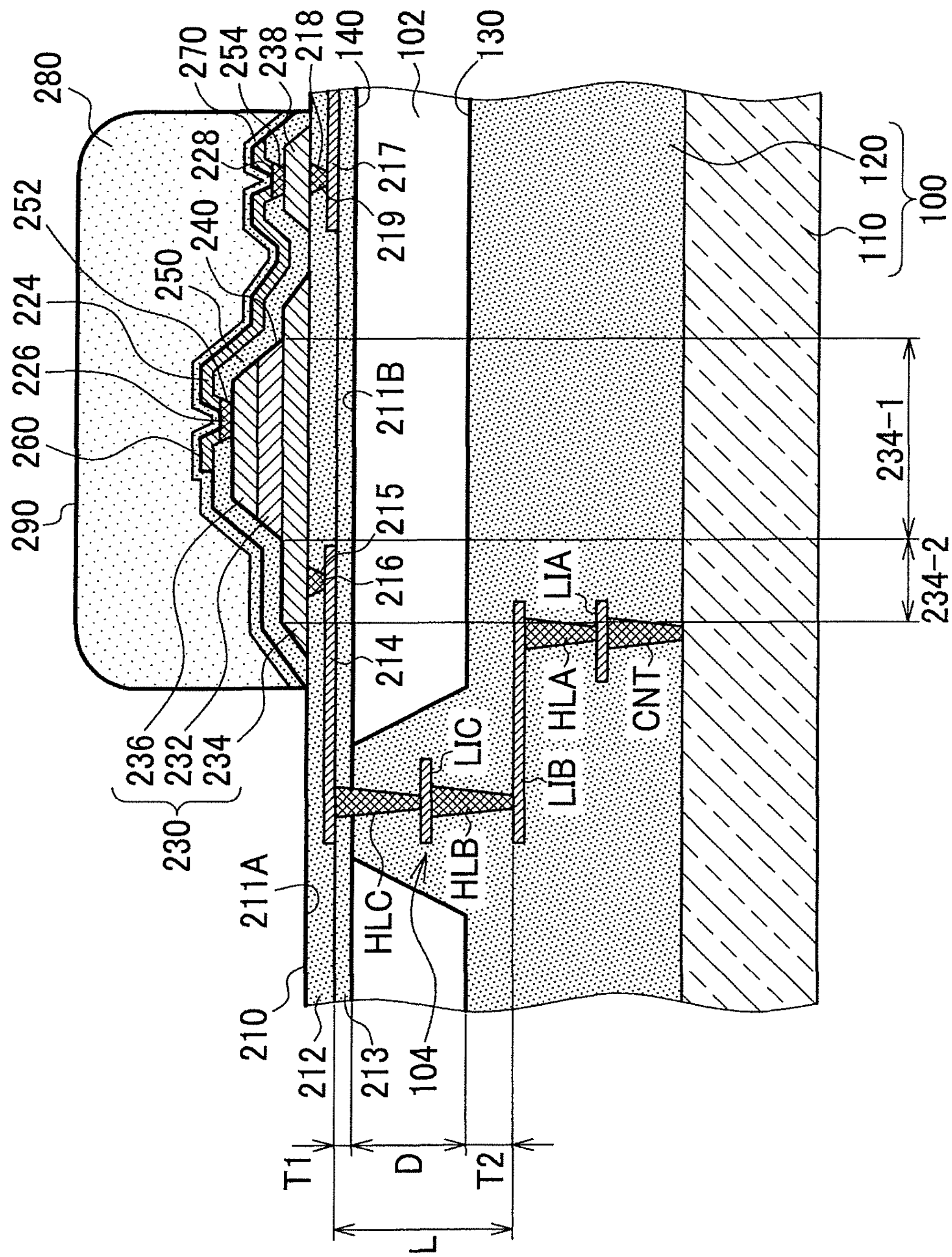
U.S. PATENT DOCUMENTS

8,449,177	B2 *	5/2013	Kvisteroy et al.	374/143
8,809,980	B2 *	8/2014	Nakatani	257/428
8,851,748	B2 *	10/2014	Noda	374/121
2003/0133489	A1 *	7/2003	Hirota et al.	374/121
2003/0147449	A1 *	8/2003	Chavan et al.	374/137
2009/0250823	A1 *	10/2009	Racz et al.	257/778
2011/0002359	A1 *	1/2011	Benzel et al.	374/178
2012/0213245	A1 *	8/2012	Noda	374/44

FOREIGN PATENT DOCUMENTS

JP	09-203659	A	8/1997
JP	10-104062	A	4/1998
JP	10-185681	A	7/1998
JP	2003-166876	A	6/2003
JP	2008-232896	A	10/2008

* cited by examiner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270
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218
140
102
130
252
228
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219
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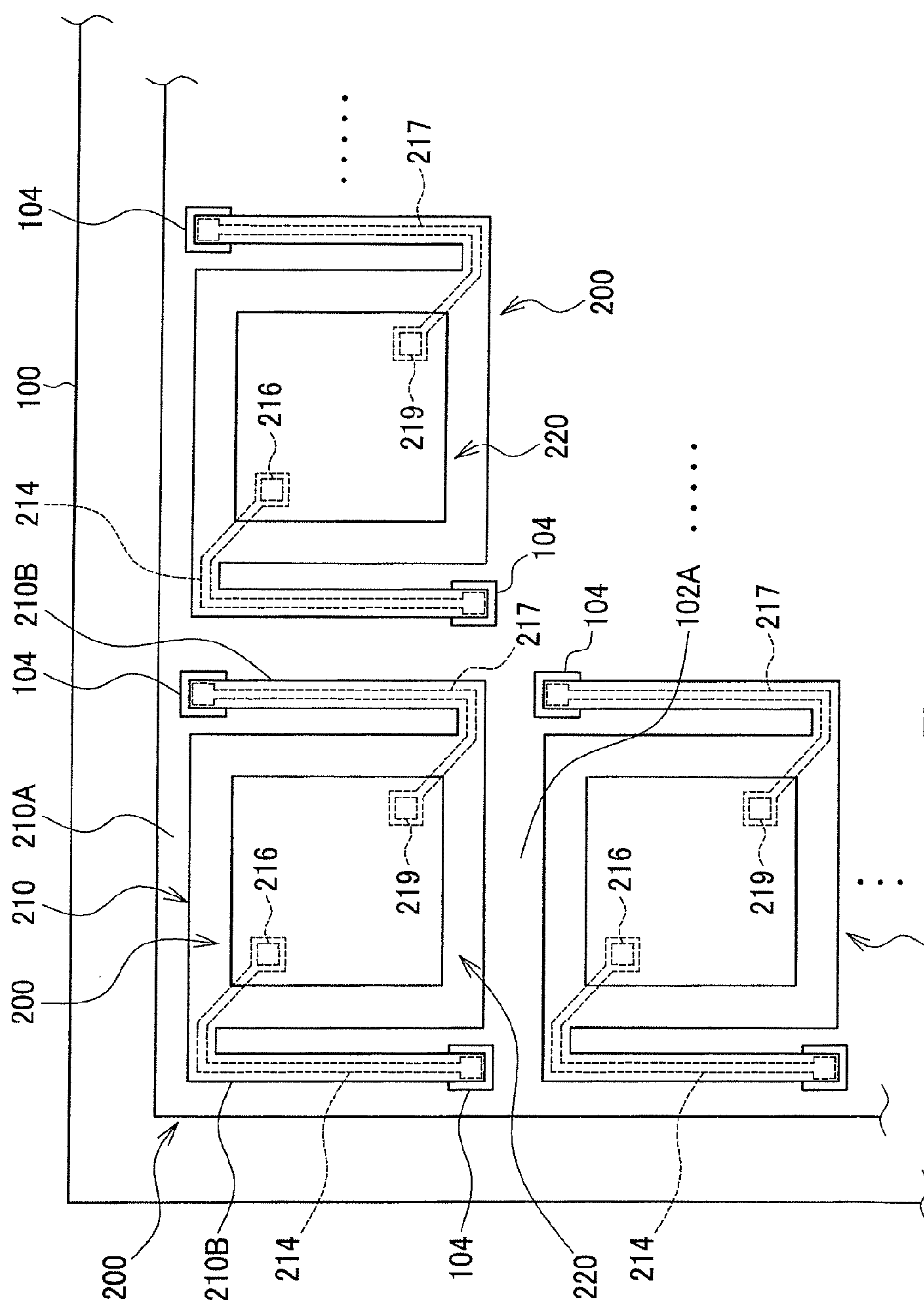
260
234-1
290
215
216
234-2
LIA
214
HLA
CNT
LIC
LIB
236
232
234
230
211A
HLC
HLB
104
210
212
213
T1
D
T2
L

Fig. 1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104
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210B
104
210A
210
200
217
200
216
219
220
104
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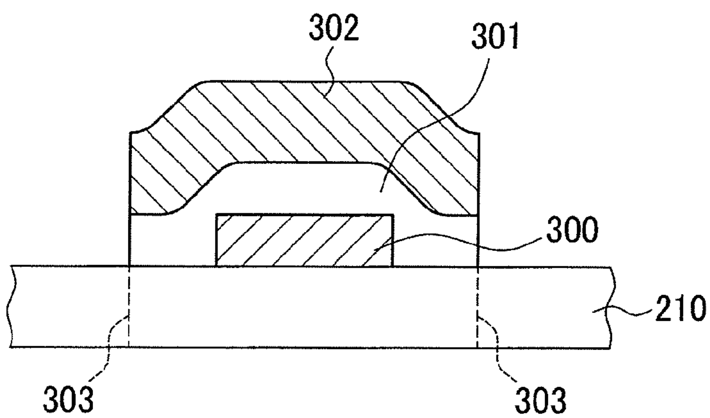
217
216
219
102A
104
217
216
219
200
200
210B
214
104
220
214

Fig. 2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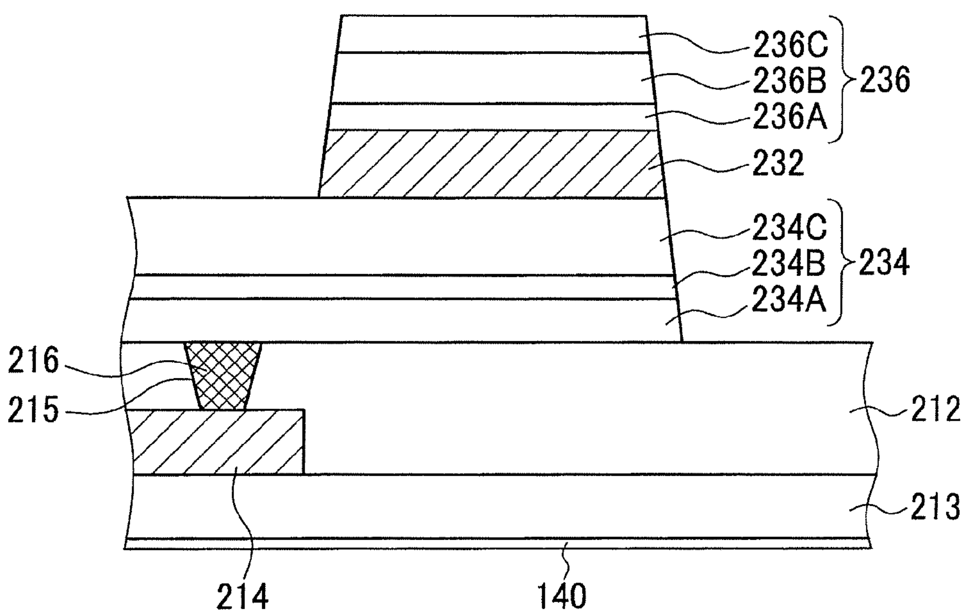
301
300
210
303
303

Fig. 3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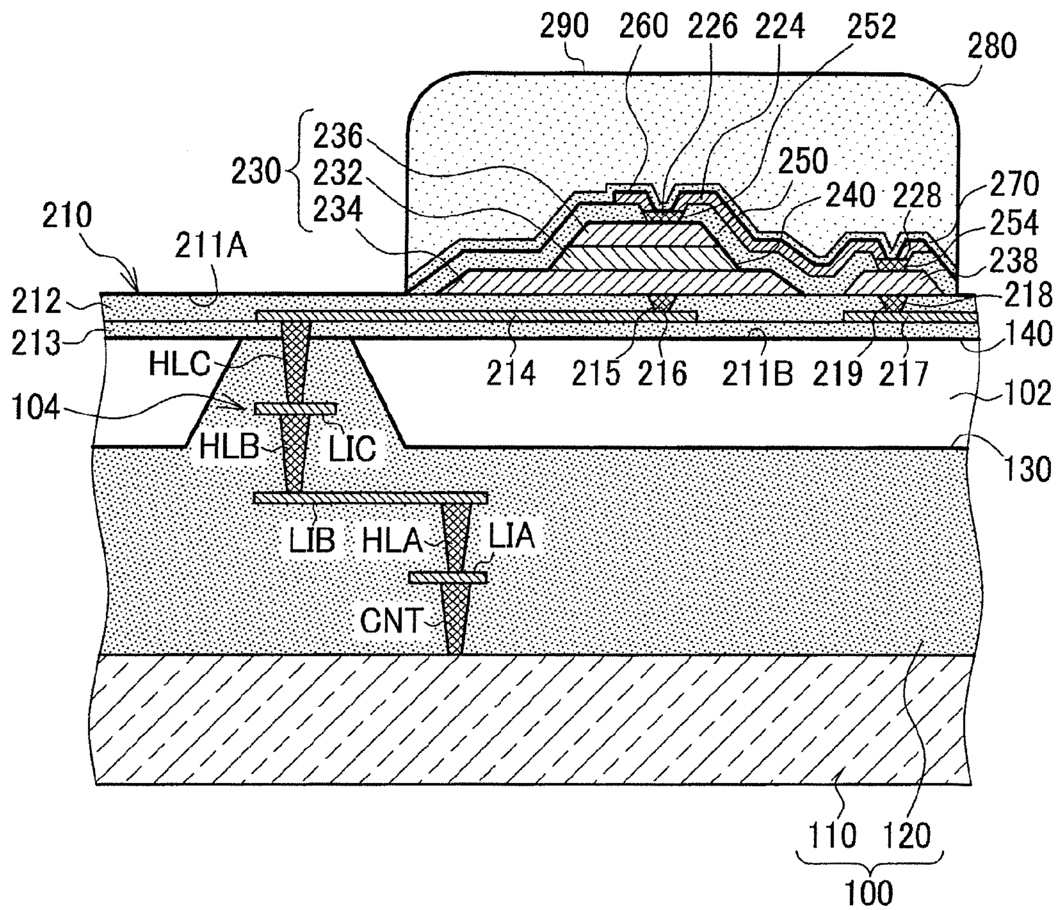
236B
236A
236
232
234C
234B
234A
234
216
215
212
213
214
140

Fig. 4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252
280
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236
232
234
250
240
228
270
254
238
210
211A
212
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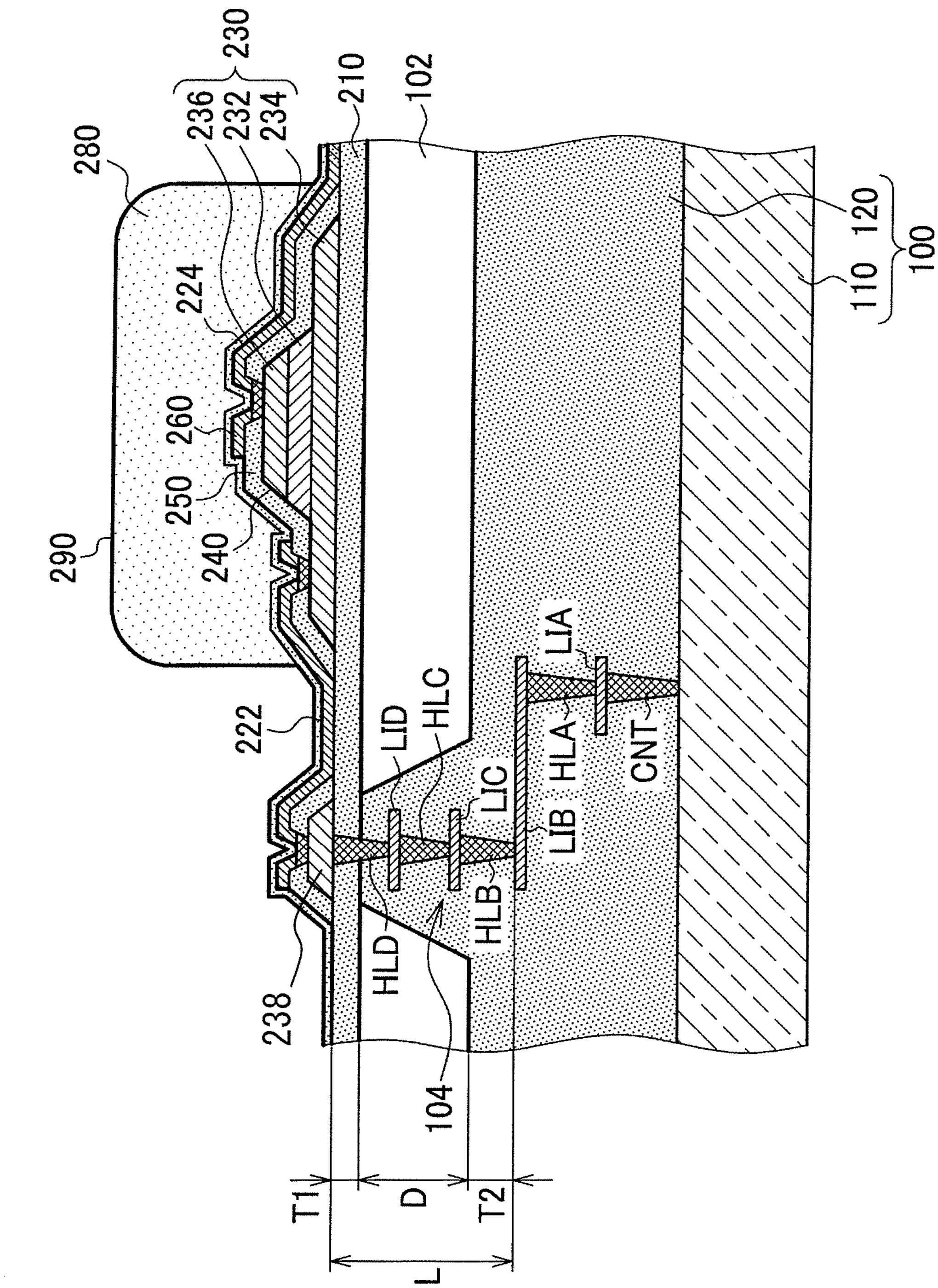
213
140
HLC
214
215
216
211B
219
217
102
104
HLB
LIC
130
LIB
HLA
LIA
CNT
120
110
100

Fig. 5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236
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210
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280
224
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240
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222
238
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104
HLB
LID
HLC
LIC
LIB
HLA
LIA
CNT
120
110
100
T1
D
T2
L

Fig. 6

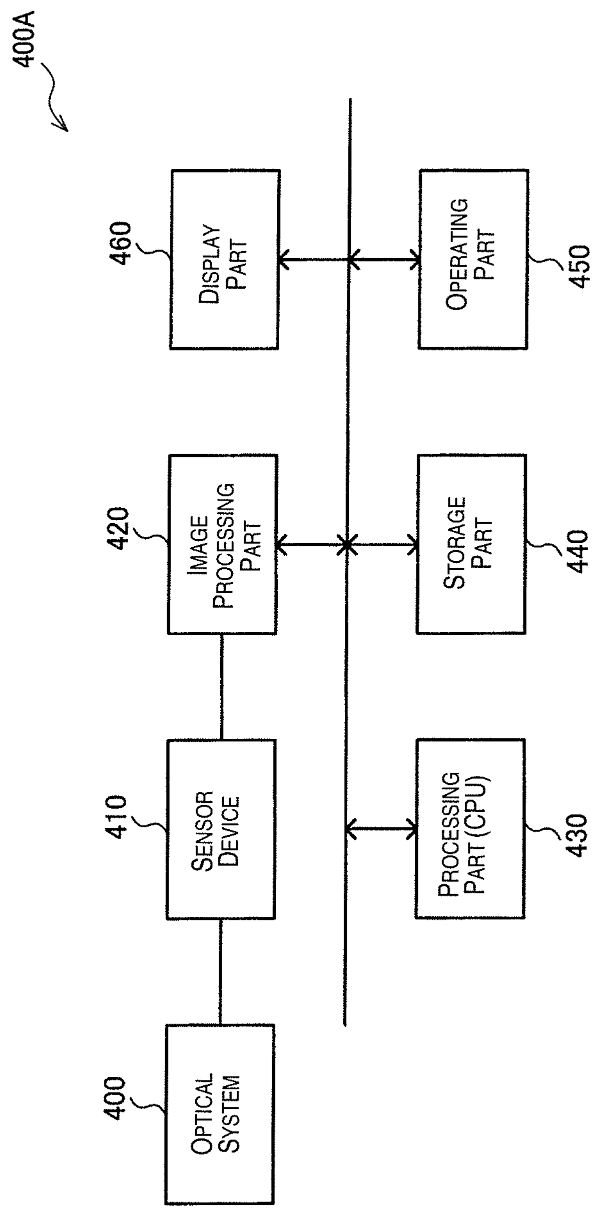
400A
460
DISPLAY PART
450
OPERATING PART
420
IMAGE PROCESSING PART
440
STORAGE PART
410
SENSOR DEVICE
430
PROCESSING PART (CPU)
400
OPTICAL SYSTEM

Fig. 7

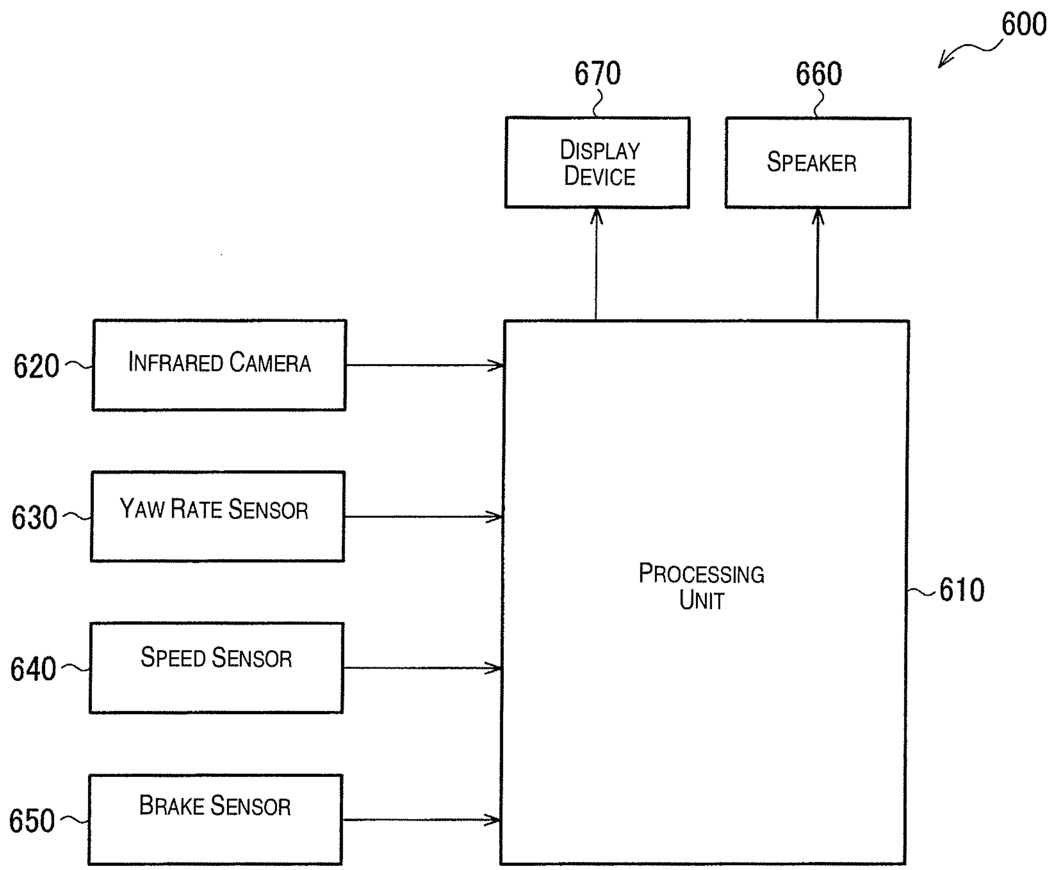
600
670
660
DISPLAY DEVICE
SPEAKER
620
INFRARED CAMERA
630
YAW RATE SENSOR
640
SPEED SENSOR
650
BRAKE SENSOR
PROCESSING UNIT
610

Fig. 8

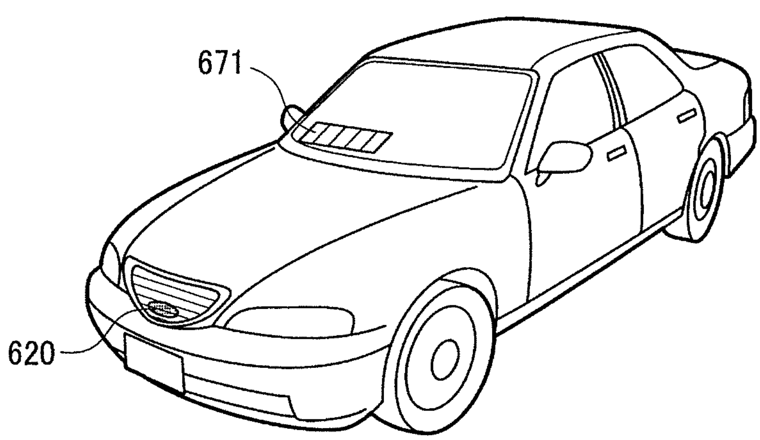
671
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Fig. 9

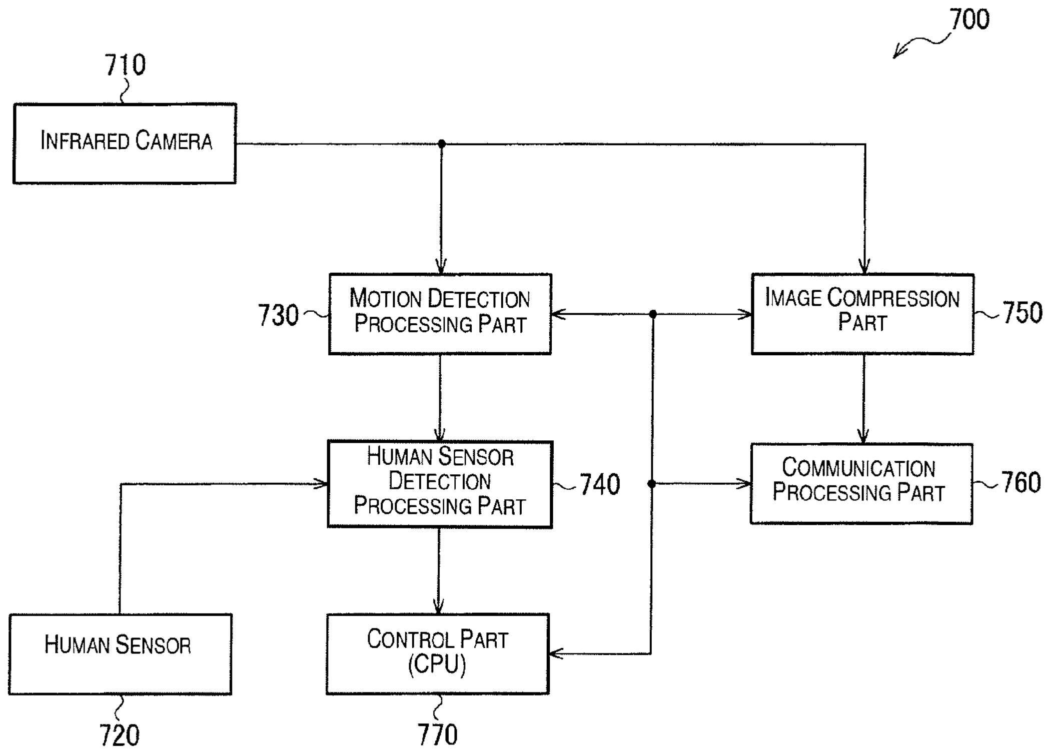
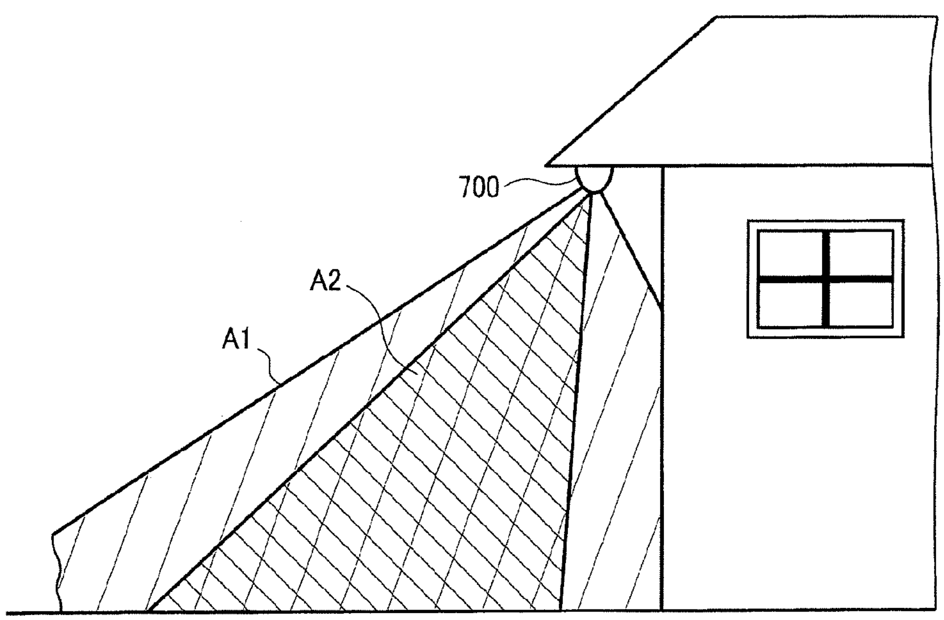

700
710
INFRARED CAMERA
MOTION DETECTION PROCESSING PART
730
IMAGE COMPRESSION PART
750
HUMAN SENSOR DETECTION PROCESSING PART
740
COMMUNICATION PROCESSING PART
760
HUMAN SENSOR
CONTROL PART (CPU)
720
770

Fig. 10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A2
A1

Fig. 11

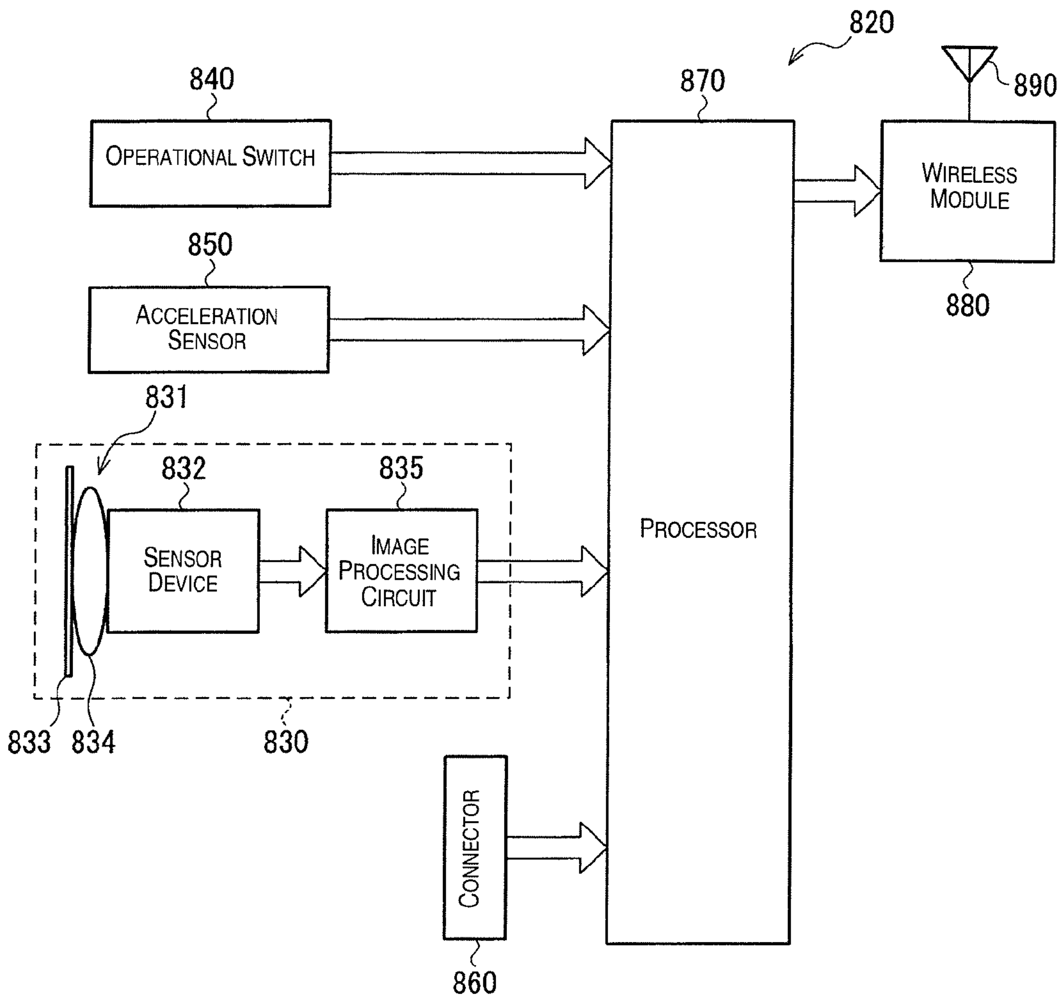
820
840
OPERATIONAL SWITCH
850
ACCELERATION SENSOR
870
PROCESSOR
890
WIRELESS MODULE
880
831
832
SENSOR DEVICE
835
IMAGE PROCESSING CIRCUIT
833
834
830
CONNECTOR
860

Fig. 12

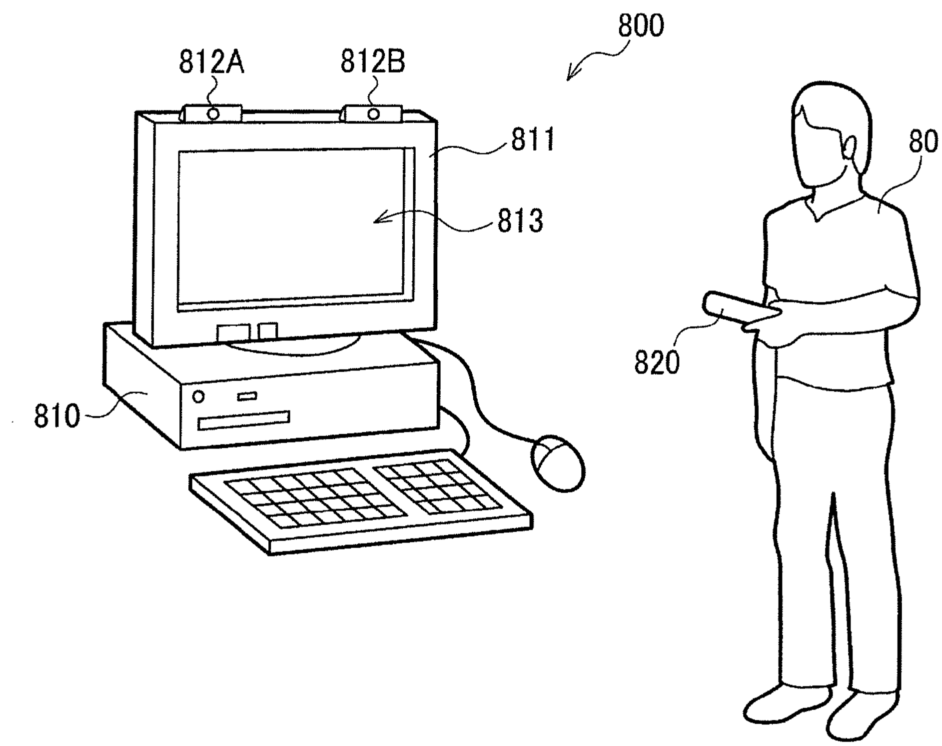
800
812A
812B
811
813
801
820
810

Fig. 13

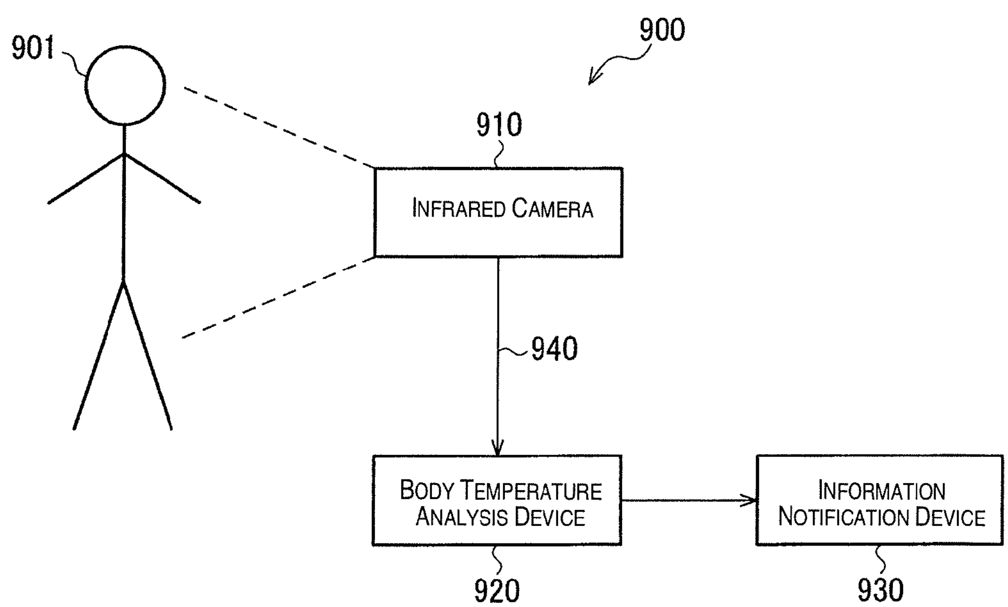
901
900
910
Infrared Camera
940
Body Temperature Analysis Device
Information Notification Device
920
930

Fig. 14

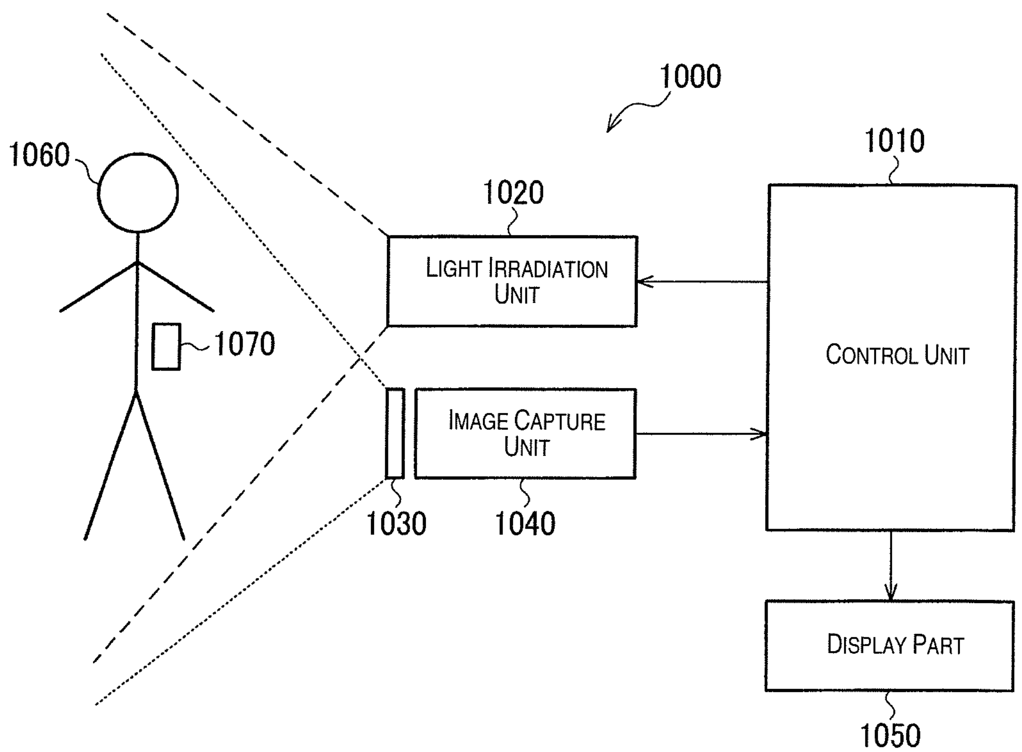
1000
1060
1010
1020
LIGHT IRRADIATION UNIT
1070
CONTROL UNIT
IMAGE CAPTURE UNIT
1030
1040
DISPLAY PART
1050

Fig. 15

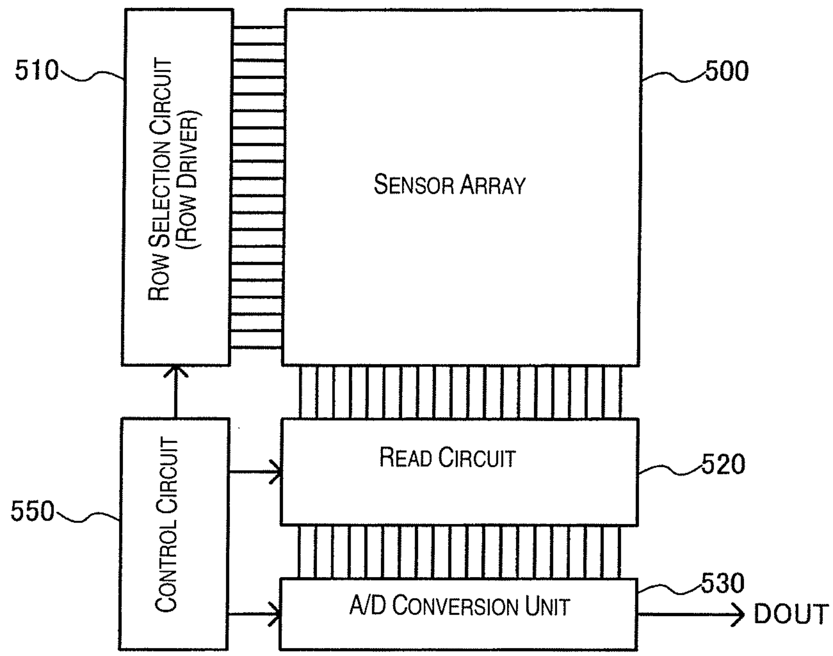

Fig. 16A

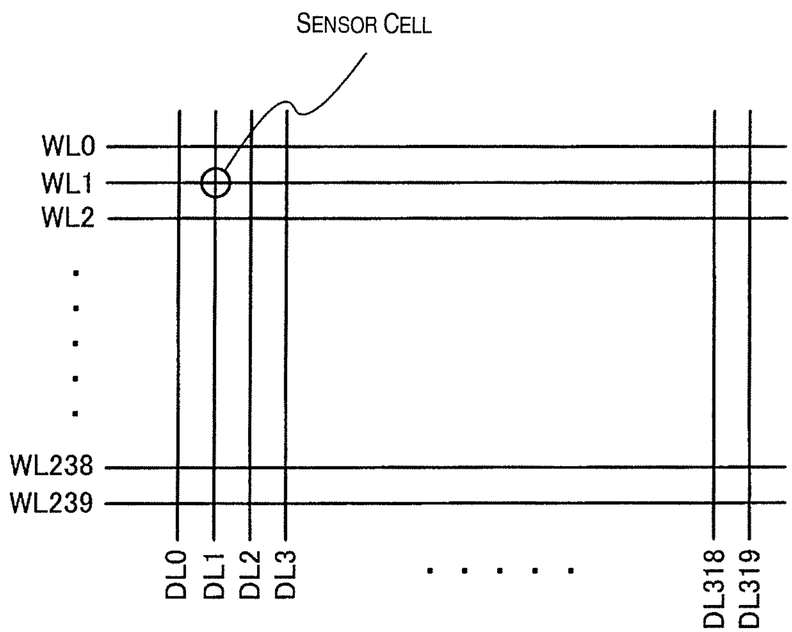

Fig. 16B

THERMAL DETECTOR, THERMAL DETECTION DEVICE, AND ELECTRONIC INSTRUMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to Japanese Patent Application No. 2011-036672 filed on Feb. 23, 2011. The entire disclosure of Japanese Patent Application No. 2011-036672 is hereby incorporated herein by reference.

BACKGROUND

1. Technical Field

The present invention relates to a thermal detector, a thermal detection device, and an electronic instrument.

2. Related Art

Pyroelectric-type and bolometer-type infrared detection devices are known to be thermal detection devices. With infrared detection devices, infrared light is detected as the result of using the change in spontaneous polarization amount of a pyroelectric body material (pyroelectric effect or pyroelectron effect) occurring in accordance with the amount of infrared light that has been absorbed (temperature) in order to produce excitation force (charge due to polarization) across the two terminals of the pyroelectric body (pyroelectric-type) or in order to bring about a change in resistance value in accordance with temperature (bolometer-type). The process for producing pyroelectric infrared detection devices is complicated in comparison to bolometer-type infrared detection devices, but they have the advantage of superior detection sensitivity.

Cells of pyroelectric infrared detection devices have infrared detecting elements that contain capacitors that are formed from a pyroelectric body that is connected to an upper electrode and a lower electrode. Various types of electrode and pyroelectric body materials, as well as electrode wiring structures, have been offered (see, Japanese Laid-Open Patent Application Publication No. 10-104062).

In addition, because the thermal detection element is mounted on a membrane (support member), and a cavity part is formed between the membrane and the substrate on which the thermal detection element is formed, the thermal detection element is thermally isolated from the substrate.

In addition, studies are being conducted regarding configurations in which a detection circuit disposed on the substrate and the detection circuit is connected to the infrared detector using wiring that is disposed on the membrane.

SUMMARY

In accordance with a number of aspects of the present invention, a thermal detector, a thermal detection device, and an electronic instrument can be offered whereby the spacer members that define the depth of the cavity part whereby the thermal detection element is thermally isolated from the substrate is also used as a wiring structure. As a result of this wiring structure, it is possible to ensure a cavity part depth whereby thermal isolation is reliably provided.

A thermal detector according to one aspect of the present invention includes a substrate, a support member, a spacer member, a thermal detection element, a detection circuit and a wiring part. The support member has a first surface and a second surface opposite from the first surface. The spacer member is connected to the substrate and supporting the support member so that a cavity part is formed between the

substrate and the second surface of the support member. The thermal detection element is supported on the first surface of the support member. The detection circuit is disposed on the substrate and connected to the thermal detection element. The wiring part connects the thermal detection element and the detection circuit. The wiring part has a first conductive layer part, a second conductive layer part, a third conductive layer part and a plurality of plugs. The first conductive layer part includes at least one layer disposed in the substrate. The second conductive layer part includes at least one layer disposed in the spacer member. The third conductive layer part includes at least one layer supported by the support member. The plugs respectively connect adjacent layers of the first conductive layer part, the second conductive layer part and the third conductive layer part, in a thickness direction of the substrate.

According to another aspect of the present invention, at least one layer of the second conductive layer part is disposed inside the spacer member, and respective plugs connect with the back surface of the at least one layer of the second conductive layer part. Consequently, the height of the spacer member is a height that is close to the height that is obtained by adding the length of the two plugs to the thickness of the layer of the second conductive layer part. In general, the length of the plugs is about 1 μm, for example, and the height of the spacer member is thus, for example, about 2 μm. As a result, a depth of about 2 μm is ensured for the depth of the cavity part. On the other hand, when only plugs are disposed on the spacer member, the height of the spacer member is about 1 μm, and thus a depth of only about 1 μm can be ensured for the depth of the cavity part. In this case, there is the danger that the support member will bend within the cavity part and will contact the substrate, which will make it impossible to reliably ensure thermal isolation of the thermal detection element from the substrate. In an embodiment of the present invention, the spacer member that defines the depth of the cavity part also functions as the wiring structure, and as a result of this wiring structure, it is possible to ensure a cavity part depth that will reliably provide thermal isolation.

In another aspect of the present invention, the at least one layer of the third conductive layer part is preferably disposed in the support member at a position that is not exposed on the first surface of the support member.

When the layer of the third conductive layer part is buried in the support member in this manner, the pathways for connection with the plugs can be shortened in comparison to when the layer of the third conductive layer part is exposed on the first surface of the support member. As a result, the second conductive layer part can be formed as a single layer in the spacer member. When the second conductive layer part is just one layer, the margins for positioning can be reduced, and it is possible to reduce the planar surface area of the spacer member that has a tapered form in accordance with the process parameters of isotropic etching. As a result, increased integration levels are possible.

In another aspect of the present invention, each of a thermal conductivity of the at least one layer of the first conductive layer part and a thermal conductivity of the at least one layer of the second conductive layer part is preferably less than a thermal conductivity of each of the plugs. As a result, the wiring structure in the spacer member can be prevented from acting as a heat-release pathway, and thermal isolation of the thermal detection element can be ensured.

In another aspect of the present invention, the thermal detection element preferably includes a first electrode mounted on the support member, a second electrode opposed to the first electrode, and a pyroelectric body disposed between the first and second electrodes, with the first electrode including a first region on which the pyroelectric body is layered, and a second region protruding from the first region in plan view, and the support member preferably has an insulating layer with the at least one layer of the third conductive layer being disposed on a side of the second surface of the support member with respect to the insulating layer, and a first plug passing through the insulating layer at a position where the second region of the first electrode and the at least one layer of the third conductive layer part overlap in plan view to connect the second region of the first electrode with the at least one layer of the third conductive layer part.

In this aspect of the present invention, the wiring that connects with the first electrode can be formed by the at least one layer of the third conductive layer part and the first plug that is formed in the support member. The first plug is formed in the support member at a position that is not opposite the capacitor having the pyroelectric body in between the first and second electrodes and is thus not related to the planarity or the like of the support member that is opposite the capacitor, and the orientation of the capacitor is maintained. The wiring that connects to the first electrode is led off via the first plug, and thus a step is not formed in the pyroelectric-type detecting element or support member due to the wiring to the first electrode. When the planarity of the support member is ensured, the precision of resist formation is increased, and shape processability of the support member is improved. In addition, because the third conductive layer is buried in the support member, the pathway for connecting with the plug can be made short, and the second conductive layer part can be formed as a single layer in the spacer member.

In another aspect of the present invention, the thermal detection element preferably includes a first electrode mounted on the support member, a second electrode opposed to the first electrode, and a pyroelectric body disposed between the first and second electrodes, and the support member preferably has an insulating layer with the at least one layer of the third conductive layer being disposed on a side of the second surface of the support member with respect to the insulating layer, and a first plug passing through the insulating layer at a position where the pyroelectric body and the at least one layer of the third conductive layer part overlap in plan view to connect the first electrode and the at least one layer of the third conductive layer.

In this aspect of the present invention, the wiring that connects to the first electrode can be formed by the first plug formed in the support member and the layer of the third conductive layer part. The first plug is formed in the support member at a position that is opposite the capacitor in which the first electrode and the pyroelectric body are layered, and thus the element surface area is not increased in order to provide wiring for connecting with the first electrode. As a result, a pyroelectric detector can be provided that is suitable for increasing the level of integration. The wiring that connects with the first electrode is lead off via the first plug, and thus a step is not formed in the pyroelectric-type detecting element or support member by the wiring to the first electrode. When the planarity of the support member is ensured, the resist is formed with increased precision, and shape processing of the support member is improved. Moreover, because the layer of the third conductive layer part is buried in the support member, the pathway for connecting with the plug can be made shorter, and the second conductive layer part can be formed as a single layer in the spacer member.

In another aspect of the present invention, the thermal detection element is preferably a bolometer in which a resistance value changes depending on a temperature. In other words, the thermal detector of the present invention includes at least a pyroelectric detector and a bolometer.

A thermal detection device pertaining to another aspect of the present invention has a plurality of the thermal detectors according to any of the above described aspects arranged two-dimensionally along two intersecting axes. This thermal detection device has high detection sensitivity in the thermal detectors of each cell, and a clear light (temperature) distribution image can be provided.

An electronic instrument of yet another aspect of the present invention has the thermal detectors or the thermal detection device according to any of the above described aspects. By using one or a plurality of cells containing the thermal detectors as a sensor, the invention is optimal for use in thermographic devices that output a light (temperature) distribution image, automobile navigation or surveillance cameras, as well as analytical instruments (measurement instruments) for analyzing (measuring) physical data related to an object, security instruments for detecting fire or heat, and factory automation (FA) instruments that are installed in factories and the like.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the attached drawings which form a part of this original disclosure:

FIG. **1** is a schematic sectional view of the pyroelectric detector for one cell in a pyroelectric infrared detection device according to an embodiment of the present invention;

FIG. **2** is a schematic plan view of a pyroelectric infrared detection device according to an embodiment of the present invention;

FIG. **3** is a diagram showing a comparative example of a support member having a step;

FIG. **4** is an enlarged view of the support member and a capacitor of a pyroelectric infrared detection device according to an embodiment of the present invention;

FIG. **5** is a schematic sectional view of a pyroelectric detector for one cell in a pyroelectric infrared detection device according to another embodiment of the present invention;

FIG. **6** is a schematic sectional view of a pyroelectric detector for one cell in a pyroelectric infrared detection device according to yet another embodiment of the present invention;

FIG. **7** is a block diagram of an infrared camera (electronic instrument) that has a pyroelectric detector or a pyroelectric detection device;

FIG. **8** is a diagram showing an on-board assistance device (electronic instrument) that has an infrared camera;

FIG. **9** is a diagram showing an automobile having the infrared camera shown in FIG. **7** mounted on its front;

FIG. **10** is a diagram showing a security device (electronic instrument) that has an infrared camera;

FIG. **11** is a diagram showing the detection area for a human sensor and an infrared camera in a security instrument shown in FIG. **10**;

FIG. **12** is a diagram showing a controller that is used in a gaming device that has the sensor device shown in FIG. **7**;

FIG. **13** is a diagram showing a gaming device comprising the controller shown in FIG. **12**;

FIG. **14** is a diagram showing a body temperature measurement device (electronic instrument) that has an infrared camera;

FIG. **15** is a diagram showing an example of a configuration in which the sensor device of FIG. **7** is used as a terahertz sensor device in combination with a terahertz irradiation unit in a special material inspection device (electronic instrument); and

FIGS. **16**A and **16**B are diagrams showing an example of the configuration of a pyroelectric detection device in which pyroelectric detectors are disposed two-dimensionally.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Preferred embodiments of the present invention are described in detail below. The present invention described in the claims is not unfairly limited by the embodiments described below, and the entireties of the configurations described in the embodiments are not necessarily essential in regard to means for solving the problems according to the present invention

1. Thermal Infrared detection Device

FIG. **2** shows a pyroelectric infrared detection device (more broadly, a thermal detection device) that has, arranged in a plurality of units along two intersecting straight lines, e.g., along two orthogonal axes, pyroelectric infrared detectors **200** having a plurality of cells in which the support member **210** shown in FIG. **1** and a thermal detection element, e.g., the pyroelectric-type detecting element **220**, that is mounted thereupon are provided for each cell. The pyroelectric infrared detection device may also be configured using single-cell pyroelectric infrared detectors **200**. A plurality of posts **104** are provided upright relative to the substrate **100**, and single-cell pyroelectric infrared detectors **200** supported on, e.g., two posts (spacer members) **104** are arranged in rows along two mutually orthogonal axial directions, in FIG. **2**. The region taken up by the pyroelectric infrared detector **200** of a single cell is, for example, 30×30 μm.

As shown in FIG. **2**, the pyroelectric infrared detector **200** comprises a support member (membrane) **210** that is supported on two posts **104**, and an infrared detecting element **220**. The region taken up by the pyroelectric infrared detecting element **220** of a single cell is, for example 20×20 μm.

The pyroelectric infrared detector **200** of a single cell is connected with the two posts **104** and is otherwise not in contact with anything else, with a cavity part **102** (refer to FIG. **1**) being formed under the pyroelectric infrared detector **200**. An opening **102**A that is in communication with the cavity part **102** is disposed at the periphery of the pyroelectric infrared detector **200** in plan view. As a result, the pyroelectric infrared detector **200** of a single cell is thermally isolated from the substrate **100** and pyroelectric infrared detectors **200** of other cells. In other words, the posts **104** function as spacer members for forming the cavity part **102** between the support member **210** and the substrate **100**. The spacer member has a prescribed height over the substrate from the surface of the substrate toward the support member, and the member can connect with a part of a second surface of the support member and a part of the substrate, so that there is no contact between the substrate and the support member. In addition, the shape of the posts **104** that serve as spacer members is not limited to columns, and the spacer member may be formed in the shape of a frame, grid, or the like.

The support member **210** has a mounting part **210**A whereby the infrared detection element **220** is mounted and supported, and two arms **210**B that are linked to the mounting part **210**A. The free ends of the two arms **210**B are linked to the posts **104**. The two arms **210**B are thin and long and have extra length in order to thermally isolate the infrared detection element **220**.

FIG. **2** shows a first wiring layer **214** and a second wiring layer **217** that are disposed on the support member **210**. The first and second wiring layers **214**, **217** extend along the arms **210**B and connect to the circuit in the substrate **100** via the posts **104**. The first and second wiring layers **214**, **217** also are thin and long and have extra length in order to thermally isolate the infrared detection element **220**.

2. Summary of Pyroelectric Infrared Detector

FIG. **1** is a sectional view of the pyroelectric infrared detector **200** shown in FIG. **2**. With the pyroelectric infrared detector **200**, the cavity part **102** in FIG. **1** is embedded in a sacrificial layer (not shown) during the production process. This sacrificial layer is present from prior to the step for forming the support member **210** and the pyroelectric infrared detection element **220** to after this step. The layer is removed by isotropic etching subsequent to the step for forming the pyroelectric infrared detection element **220**.

As shown in FIG. **1**, the substrate **100** comprises a silicon substrate **110** and an insulating layer (e.g., SiO_2) **120** that is on the silicon substrate **110**. The posts **104** are formed by etching the insulating layer **120** and are composed, for example, of SiO_2. The posts **104** and the wiring structure in the insulating layer **120**, as shown in FIG. **1**, are configured using a plurality of metal layers L1A to LIC and a plurality of plugs CNT, HLA, HLB, and HLC that connect thereto. This wiring is connected to the detection circuit that is formed as a well-known MOS transistor structure in the silicon substrate **110** shown in FIG. **1**. The detection circuit can comprise a row selection circuit (row driver) and a read circuit that reads the data from the detectors via column lines (described in reference to FIG. **16**A below). The detecting circuit may be a connection terminal that is formed opposite the first electrode and the second electrode of the pyroelectric infrared detecting element **220** on the surface of the silicon substrate **110** that is on the opposite side from the surface on which the support member **210** and the pyroelectric infrared detecting element **220** are formed. The terminal and a semiconductor element of another substrate can be connected, and a signal can be read out from the detector. The cavity part **102** is formed simultaneous to the posts **104** by etching the insulating layer **120**. The opening part **102**A shown in FIG. **2** is formed by pattern-etching the support member **210**.

The infrared detection element **220** that is mounted on a first surface **211**A of the support member **210** includes a capacitor **230**. The capacitor **230** comprises a pyroelectric body **232**, a first electrode (lower electrode) **234** that is connected to the lower surface of the pyroelectric body **232**, and a second electrode (upper electrode) **236** that is connected to the upper surface of the pyroelectric body **232**. The first electrode **234** may also comprise a binding layer (not shown) that increases binding with the support member **210**.

2.1. First Reducing Gas Barrier Layer

The capacitor **230** is covered by a first reducing gas barrier layer **240** that inhibits ingress of reducing gas (e.g., hydrogen, water vapor, OH groups, methyl groups) into the capacitor **230** in the steps after the formation of the capacitor **230**. This is done because the pyroelectric body **232** (e.g., PZT) of the capacitor **230** is an oxide, and its oxygen is depleted when the oxide is reduced, leading to loss of the pyroelectric effect.

The first reducing gas barrier layer **240** can comprise a lower first barrier layer and an upper second barrier layer. The first barrier layer can be formed by film growth involving, for example, the sputtering of aluminum oxide, Al_2O_3. Because reducing gas is not used in sputtering, reduction of the capacitor **230** will not occur. The second hydrogen barrier layer can be formed by film growth involving, for example, atomic layer chemical vapor deposition (ALCVD) using aluminum oxide, Al_2O_3. Reducing gas is used in ordinary CVD (chemical vapor deposition), but the capacitor **230** is isolated from the reducing gas by the first barrier layer.

The total layer thickness of the first reducing gas barrier layer **240** is 50 to 70 nm, e.g., 60 nm. At this time, the first barrier layer that is formed by CVD is thicker than the second barrier layer that is formed by atomic layer chemical vapor deposition (ALCVD), which is thinner, at 35 to 65 nm, e.g., 40 nm. In contrast, the second barrier layer that is formed by atomic layer chemical vapor deposition (ALCVD) can be thin and may be formed by film growth of, for example, aluminum oxide, Al_2O_3, at 5 to 30 nm, e.g., 20 nm. Atomic layer chemical vapor deposition (ALCVD) has superior embedding characteristics in comparison to sputtering or the like. The method thus can be utilized for the production of fine detail, and the reducing gas barrier properties can be enhanced by the first and second barrier layers. Moreover, the first barrier layer that is grown by a sputtering method is not as dense as the second barrier layer, which has the effect of decreasing thermal transfer, thereby preventing dissipation of heat from the capacitor **230**.

The interlayer insulating layer **250** is formed on the first reducing gas barrier layer **240**. In general, when raw material gas (TEOS) for the interlayer insulating layer **250** undergoes a chemical reaction, reducing gasses such as hydrogen gas or water vapor are generated. The first reducing gas barrier layer **240** that is provided at the periphery of the capacitor **230** protects the capacitor **230** from reducing gas that is generated during formation of the interlayer insulating layer **250**.

A second electrode (upper electrode) wiring layer **224** is disposed on the interlayer insulating layer **250**. In other words, the interlayer insulating layer **250** insulates the second electrode wiring layer **224** from the first and second electrodes **234**, **236** in the capacitor **230**. The interlayer insulating layer **250** functions as an electrically insulating body, whereas the pyroelectric body **232** functions as a dielectric body. A hole **252** and a hole **254** are formed in the interlayer insulating layer **250** prior to formation of the electrode wiring. At this time, a contact hole is similarly formed in the first reducing gas barrier layer **240**. The second electrode (upper electrode) **236** and the second electrode wiring layer **224** are made to be in continuity by the plug **226** that is embedded in the hole **252**.

A mediating conductive layer **238** that connects with the second electrode wiring layer **224** may be present on the first surface **211**A of the support member **210**. Due to a plug **228** that is embedded in the hole **254**, continuity is produced between the second electrode (upper electrode) **236** and the mediating conductive layer **238**. The mediating conductive layer **238** may be formed in the same structure as the first electrode **234** and in the same process as the first electrode **234**.

If an interlayer insulating layer **250** is not present, then when the second electrode (upper electrode) wiring layer **224** are pattern-etched, the second barrier layer of the first reducing gas barrier layer **240** therebelow will be etched, and the barrier properties will decrease. The interlayer insulating **250** is necessary in order to ensure the barrier properties of the first reducing gas barrier layer **240**.

The interlayer insulating layer **250** preferably has a low hydrogen content. The interlayer insulating layer **250** is subjected to a degassing treatment by annealing. In this manner, the hydrogen content of the interlayer insulating layer **250** is made to be lower than in a passivation layer **270** that covers the second electrode wiring layer **224**.

2.2. Second Reducing Gas Barrier Layer

The first reducing gas barrier layer **240** of the top surface of the capacitor **230** is closed and does not have a hole during formation of the interlayer insulating layer **250**, and thus reducing gas does not enter into the capacitor **230** during formation of the interlayer insulating layer **250**. However, after formation of a hole in the first reducing gas barrier layer **240**, the barrier properties deteriorate. A preferred example whereby this is prevented may involve adding a second reducing gas barrier layer **260** that encompasses the first reducing gas barrier layer **240**. The second reducing gas barrier layer **260** makes up for deterioration of barrier properties due to the deficiency in the first reducing gas barrier layer **240** resulting from formation of the hole **252**. It is thus desirable for the second reducing gas barrier layer **260** to be formed so that it covers at least the plug **226** that is embedded in the hole **252**, but the layer may also be formed so as to cover the first reducing gas barrier layer **240** in order to inhibit reducing gas wraparound.

The second reducing gas barrier layer **260** is formed on the second electrode wiring layer **224**, and it is thus necessary to provide a thin film in order to inhibit the transfer of heat and release of heat. In addition, because the interlayer insulating layer **250** has infrared absorption effects, it is preferable to facilitate the passage of infrared light (wavelength range 8 to 14 μm) by producing the second reducing gas barrier layer **260** as a thin film.

To this end, in this embodiment, the second reducing gas barrier layer **260** is formed from aluminum oxide Al_2O_3 and is produced as a film that is thinner than the first reducing gas barrier layer **240**. To this end, the second reducing gas barrier layer **260** is formed by e.g., atomic layer chemical vapor deposition (ALCVD), which allows the layer thickness to be adjusted at the level of the size of atoms. The layer thickness of the second reducing gas barrier layer **260** is 20 nm, for example. As described above, atomic layer chemical vapor deposition (ALCVD) has superior embedding characteristics in comparison to sputtering and the like, and this method thus allows the production of fine detail and the formation of a dense layer at the atomic level. The reducing gas barrier properties can thus be increased, even when a thin film is used. With normal CVD methods, a thick layer is produced, and infrared light transmittance is thus compromised. A silicon nitride Si_3N_4 film is undesirable for the second reducing gas barrier layer **260**, because it must be formed as a thick layer of 100 nm or greater, for example, in order to ensure reducing gas barrier properties.

An SiO_2 or SiN passivation layer **270** is provided which covers the second electrode wiring layer **224**. An infrared absorbing body (more broadly, a light-absorbing member) **280** is provided on the passivation layer **270** above the capacitor **230**. The passivation layer **270** is also formed from SiO_2 or SiN, but is preferably a different material that has higher etching selectivity relative to the lower passivation layer **270**, due to the need for pattern etching the infrared absorbing body **280**. Infrared light is incident from the direction of the arrow in FIG. **1** on the infrared absorbing body **280**, and the infrared absorbing body **280** generates heat in accordance with the amount of absorbed infrared light. Because this heat is conducted to the pyroelectric body **232**, the spontaneous polarization level of the capacitor **230** changes due to the heat, and infrared light can be detected by detecting the charge that is produced by spontaneous polarization. The infrared absorbing body **280** is not restricted to being provided separately with respect to the capacitor **230**; if present in the capacitor **230**, a separate infrared absorbing body **280** need not be provided.

Although reducing gas is generated during CVD formation of the passivation layer **270** or the infrared absorbing body **280**, the capacitor **230** is protected by the first reducing gas barrier layer **240** and the second reducing gas barrier layer **260**.

2.3. Third Reducing Gas Barrier Layer

A third reducing gas barrier layer **290** is provided covering the outer surface of the infrared detector **200**, including the infrared absorbing body **280**. This third reducing gas barrier layer **290** must be formed thinner than, for example, the first reducing gas barrier layer **240** in order to increase the transmittance of infrared light (wavelength range 8 to 14 μm) that is incident on the infrared absorbing body **280**. To this end, atomic layer chemical vapor deposition (ALCVD) is utilized. However, because the third reducing gas barrier layer **290** functions as an etching stop layer as described below, it is formed thicker than the second reducing gas barrier layer **260**. In this embodiment, for example, aluminum oxide Al_2O_3 is formed by film growth at a thickness of 40 to 50 nm, e.g., 45 nm.

In addition, an etching stop layer **130** is used during isotropic etching of a sacrificial layer (not shown) that is embedded in the cavity part **102** during the process for producing the pyroelectric infrared detector **200**. This etching stop layer **130** is formed on the wall part that defines the cavity part **102** towards the substrate **100**, specifically, the side wall **104**A and the bottom wall **110**A that define the cavity part **102**. Similarly, an etching stop layer **140** is formed on the lower surface of the support member **210** as well. In this embodiment, the third reducing gas barrier layer **290** is formed from the same material as the etching stop layers **130**, **140**. In other words, the etching stop layers **130**, **140** also have reducing gas barrier properties. The etching stop layers **130**, **140** are formed by forming an aluminum oxide Al_2O_3 film at a layer thickness of 20 to 50 nm by atomic layer chemical vapor deposition (AL-CVD).

Because the etching stop layer **130** has reducing gas barrier properties, when isotropic etching of the sacrificial layer is carried out using fluoric acid in a reducing atmosphere, passage of reducing gas through the support member **210** and ingress into the capacitor **230** can be inhibited. In addition, because the etching stop layer **140** that covers the substrate **100** has reducing gas barrier properties, reduction and degradation of the wiring or transistors of the circuits that are disposed in the substrate **100** can be inhibited.

3. Basic Structure of Support Member

As shown in FIG. **1**, a post **104**, a support member **210**, and a pyroelectric infrared detection element **220** are layered on the substrate **100** sequentially from the bottom layer to the top layer. The pyroelectric infrared detection element **220** is mounted on the support member **210** on the first surface **211**A, and the second surface **211**B faces the cavity part **102**.

The support member **210**, as shown in FIG. **1**, uses a first layer member **212** on the first surface as an SiO_2 support layer (insulating layer). This SiO_2 support layer **212** has a lower hydrogen content than, for example, the post **104** which is another SiO_2 layer that is situated below the SiO_2 support layer **212**. This is achieved by decreasing the hydrogen or water content in the layer by increasing the O_2 flow rate during CVD layer film growth relative to common CVD methods for forming interlayer insulating layers. As a result, the SiO_2 support layer **212** will be a low-hydrogen layer that has a hydrogen content that is lower than, for example, the post **104** which is another SiO_2 layer (second insulating layer).

When the hydrogen content of the SiO_2 support layer **212** on the top-most layer of the support member **210** is low, the generation of reducing gas (hydrogen, water vapor) from the SiO_2 support layer **212** itself can be inhibited, even when exposed to high temperatures during heat treatment subsequent to the formation of the pyroelectric body **232**. In this manner, it is possible to inhibit reducing species that enter the pyroelectric body **232** in the capacitor **230** from directly below the capacitor **230** (from the side of the support member **210**), and it is possible to minimize the incidence of oxygen deficiency in the pyroelectric body **232**.

Although the water content of, for example, the post **104** which is another SiO_2 layer that is disposed below the SiO_2 support layer **212** can also act as a reducing species, because it is isolated from the capacitor **230**, its degree of influence is smaller than that of the SiO_2 support layer **212**. However, because the water content of the post **104** can also act as a reducing species, it is preferable to form a layer having reducing gas barrier properties in the support member **210** that is disposed below the SiO_2 support layer **212**. A detailed structure of a support member **210** that includes this feature is described below.

In other words, in this embodiment, the support member **210** can warp when formed from a single material, and is produced by layering a plurality of different materials. Specifically, the member can be formed from a first layer member **212** having the form of an oxide layer (SiO_2) and a second layer member **213** having the form of a nitride layer (e.g., Si_3N_4).

For example, residual contraction stress arising in the first layer member **212** and residual tensile stress arising in the second layer member **213** act in directions whereby they cancel each other out. As a result, it is possible to additionally decrease or eliminate residual stress in the support member **210** as a whole.

Here, the nitride layer (e.g., Si_3N_4) that forms the second layer member **213** has reducing gas barrier properties. It is thereby possible for the support member **210** to be imparted with a function for blocking reduction-impairing elements infiltrating the pyroelectric body **232** of the capacitor **230** from the support member **210**. For this reason, even with SiO_2 layers having high hydrogen content that are preset below the second layer member **213**, ingress of reducing species (hydrogen, water vapor) into the pyroelectric body **232** can be inhibited by the second layer member **213** having reducing gas barrier properties.

4. Wiring Structure for Support Member

4.1. Wiring Structure of First Electrode (Lower Electrode)

In this embodiment, as shown in FIG. **1**, the first electrode **234** comprises a first region **234-1** in which the pyroelectric body **232** is formed by layering and a second region **234-2** that is formed so as to extend from the first region **234-1**.

The support member **210** comprises a first wiring layer **214** that is disposed on a side of the second surface **211**B with respect to the first layer member **212** which is the insulating layer, a first hole **215** that is formed so as to pass through to the first layer member **212** in a position that is opposite the second region **234-2** of the first electrode **234** and the first wiring layer **214**, and a first plug **216** that is embedded in the first hole **215**.

In accordance with this embodiment, the wiring that connects to the first electrode **234** can be formed by the first wiring layer **214** and the first plug **216** that are formed in the support member **210**. The first plug **216** is formed in the support member **210** at a position that is not opposite the capacitor **230** and thus has no influence on planarity or the like of the portion of the support member **210** that is opposite the capacitor **230**. The orientation of the capacitor **230** is thus maintained, as described below.

In addition, the first hole **215** is shallow and has a small aspect ratio, and there is not an extremely strong demand in regard to planarity of the first plug **216** in the second region **234-2**. As a result, it is not necessary for the first plug **216** to be formed using a costly material having high step coverage (step filmability) such as tungsten (W).

In addition, because the wiring layer that connects to the first electrode **234** leads to the support member **210** via the first plug **216**, steps are not formed with the pyroelectric-type detection element **220** or the support member **210** due to the wiring that leads to the first electrode **234** (refer to FIG. **1**). By preserving the planarity of the support member **210**, the precision with which the resist is formed during formation of the support member **210** in the production process is increased, and the shape processability of the support member **210** is improved.

FIG. **3** shows the etching step of a comparative example. A wiring layer **300** is formed on the support member **210**, and a passivation layer **301** is then formed on the wiring layer **300**. Due to the presence of the wiring layer **300**, a step is produced, and the passivation layer **301** is not planar. Thus, the precision with which the resist **302** is formed on the passivation layer **301** is compromised. As a result, there are cases where the support member **210** cannot be etched at an original profile position **303** using the resist **302** of this type, and shape processing of the support member **210** is compromised. On the other hand, in this embodiment, since the planarity of the support member **210** is maintained, the shape processability of the support member **210** is favorable.

4.2. Wiring Structure Leading to Second Electrode (Upper Electrode)

In this embodiment, as described above, a mediating conductive layer **238** that connects to the second electrode **236** can be provided on the first surface **211**A of the support member **210**. In this case, the support member **210** can also comprise a second wiring layer **217** that is disposed on a side of the second surface **211** B with respect to the first layer member (insulating layer) **212**, a second hole **218** that is formed so as to pass through to the first layer member (insulating layer) **212** at a position that is opposite the second wiring layer **217** and the mediating conductive layer **238**, and a second plug **219** that is embedded in the second hole **218**.

In this case as well, the wiring that connects to the second electrode **236** leads to the support member **210** via the second plug **219**, and thus the support member **210** is not formed with a step due to the wiring that leads to the second electrode **236** (refer to FIG. **1**). By preserving the planarity of the support member **210**, the resist that is formed on the support member **210** in the production process is formed with high precision, and shape processing of the support member **210** is improved, as described above.

5. Relationship between Depth of Cavity Part and Wiring Structure in Spacer Member

The wiring structure of the substrate **100** and the post **104** in FIG. **1** will be considered at this point. In FIG. **1**, the metal wiring layer that is above the silicon substrate **110** has three layers, comprising a first metal layer LIA, a second metal layer LIB, and a third metal layer LIC. The first metal layer LIA and the second metal layer LIB are disposed in the insulating layer **120** of the substrate **100** below the cavity part **102**, and the third metal layer LIC is the only metal layer that is in the post **104**.

Here, at least one layer is arranged in a first conductive layer part in the substrate **100**. In this embodiment, the first conductive layer part includes two first conductive layers defined as the first metal layer LIA and the second metal layer LIB. Moreover, at least one layer is arranged in a second conductive layer part in the post **104**. In this embodiment, the second conductive layer part includes only one second conductive layer defined as the third metal layer LIC. Furthermore, at least one layer of a third conductive layer part is supported by the supporting member **210**. In this embodiment, the third conductive layer part includes only one third conductive layer defined as the first wiring layer **214** that is disposed in the supporting member **210**. The plurality of plugs that connect with the adjacent layers of the first, second, and third conductive layers LIA, LIB, LIC, **214** are defined as plugs HLA, HLB, HLC.

In the embodiment of FIG. **1**, the one second conductive layer LIC is disposed in the post **104**, and the respective plugs HLB and HLC are connected to the back surface of the second conductive layer LIC. Thus, the height of the post **104** used as the spacer member will be close to the height resulting from adding the lengths of the two plugs HLB, HLC to the thickness of the second conductive layer LIC. In general, the length of the plug is about 1 μm, and the height of the post **104** is about 2 μm, and so the depth of the cavity part **102** defined by the height of the post **104** is ensured at a depth of about 2 μm.

On the other hand, when only plugs are disposed in the post **104**, the height of the post **104** is about 1 μm, and so the depth of the cavity part **102** cannot be ensured to be a depth of about 1 μm. As a result, there is the danger that the support member **210** will bend within the cavity part **102** and will contact the substrate **100**, which will make it impossible to reliably ensure thermal isolation of the thermal detection element **220** from the substrate **100**. In the present embodiment, the post **104** that defines the depth of the cavity part **102** also functions as the wiring structure. As a result of this wiring structure, it is possible to ensure a cavity part **102** depth that can reliably provide thermal isolation.

In FIG. **1**, the first wiring layer **214** which is the third conductive layer forms part of the support member **210** by being disposed in a position that is not exposed on the first surface **211**A of the support member **210**. When the first wiring layer **214** which is the third conductive layer is buried in the support member **210** in this manner, the pathway for connection with the plug HLC is can be made shorter than if the third conductive layer were formed exposed on the first surface **211**A of the support member **210**. As a result, the second conductive layer LIC can be formed as a single layer in the post **104**. When the conductive layer in the post **104** is only one layer, the margins for positioning can be decreased, and the planar surface area of the post **104** that produces a tapered form in accordance with the process parameters of isotropic etching can be decreased. As a result, increased integration levels are possible.

In addition, the first and second conductive layers LIA, LIB, LIC that are disposed in the post **104** and the substrate **110** can be formed from titanium nitride (TiN), for example. By so doing, each of the first and second conductive layers LIA, LIB, LIC can be made from a material having a thermal conductivity that is less than that of the plurality of plugs HLA, HLB, HLC that are formed, for example, from tungsten (W). As a result, the wiring structure in the substrate **100** and the post **104** can be inhibited from serving as a heat-release pathway, thereby ensuring the thermal isolation of the thermal detection element **220**.

FIG. **1** shows an example of the dimensions that will ensure 2 μm for of the depth D of the cavity part **102**. For example, given that the length of the plug HLB is 1.1 μm, the thickness of the second conductive layer LIC is 0.2 μm, and the length of the plug HLC is 1.1 μm, then the distance L between the third conductive layer **214** and the first conductive layer LIB is 2.4 μm.

Assuming the thickness of the nitride layer (SiN) **213** of the support member **210** to be, e.g., 0.1 μm, and the thickness of the etching stop layer **140** to be, e.g., 0.05 μm, then the total thickness T**1** of the two will be 0.15 μm. From FIG. **1** it can be established that D=L−T**1** D=L−T**1**−T**2**=2.4−0.15−T**2**=2 μm. Thus, the margin thickness T**2** from the bottom part of the cavity part **102** to the first conductive layer LIB will be ensured at just 0.25 μm. In this manner, by lowering the wiring formation hurdle in the post **104**, it is possible to ensure that the depth D of the cavity part **102** that allows thermal isolation is about 2 μm.

6. Relationship between Capacitor Structure and Wiring

Next, the structure of the capacitor **230** of this embodiment will be described with reference to FIG. **4**. With the capacitor **230** shown in FIG. **4**, the crystal orientations of the pyroelectric body **232**, the first electrode **234**, and the second electrode **236** are aligned so that the preferential orientation system is the (111) plane system. Because preferential orientation occurs in the (111) plane system, the ratio of orientation in the (111) orientation is controlled at, for example, 90% or greater relative to other plane systems. In order to increase the pyroelectric constant, the (100) orientation is more preferable than the (111) orientation, but the (111) orientation is used in order to facilitate control of polarization with respect to the direction of the applied electric field. However, the preferential orientation system is not restricted to this orientation system.

6.1. Relationship between First Electrode Structure and Wiring

The first electrode **234** can comprise, sequentially from the support member **210**, an orientation control layer (e.g., Ir) **234**A that controls orientation so that the first electrode **234** is preferentially oriented in the (111) plane, a first reducing gas barrier layer (e.g., IrO_x) **234**B, and a preferentially oriented seed layer (e.g., Pt) **234**C.

The second electrode **236** can comprise, in sequence from the pyroelectric body **232**, an orientation matching layer (e.g., Pt) **236**A that matches the crystal orientation of the pyroelectric body **232**, a second reducing gas barrier layer (e.g., IrO_x) **236**B, and a resistance reduction layer (e.g., Ir) **236**C that reduces the resistance of the junction with the plug **228** that connects to the second electrode **236**.

The first and second electrodes **234**, **236** of the capacitor **230** are given a multilayered structure in this embodiment so that, despite the infrared detection element **220** having low heat capacity, processing will be performed with minimal damage and the crystal lattice level at the interface will be matched with little impact on performance; and, moreover, the pyroelectric body (oxide) **232** will be isolated from the reducing gas even if a reducing atmosphere forms around the capacitor **230** during manufacture or use.

The pyroelectric body **232** is formed by crystal growth of PZT ($Pb(Zr, Ti)O_3$, generic name: lead zirconate titanate) or PZTN (generic name for material in which Nb is added to PZT), preferentially oriented according to the (111) system, for example. Using PZTN is preferred in terms of minimizing oxidative damage and lessening the likelihood of reduction, even in a thin film. In order to bring about crystal orientation in the pyroelectric body **232**, the crystals of the first electrode **234** in the lower layer of the pyroelectric body **232** are oriented from the stage at which the first electrode **234** is formed.

To this end, an Ir layer **234**A that functions as an orientation control layer is formed by sputtering on the lower electrode **234**. It is desirable to form a titanium aluminum nitride (TiAlN) layer or a titanium nitride (TiN) layer as a binding layer under the orientation control layer **234**A. This is because binding with the SiO_2 of the SiO_2 support layer (first insulating layer) **212** used as the topmost layer of the support member **210** can thereby be ensured. Although titanium (Ti) is also suitable as this type of binding layer, titanium (Ti) is undesirable because it is highly dispersible, and thus titanium aluminum nitride (TiAlN) or titanium nitride (TiN) which have high reducing gas barrier properties and little dispersibility are preferred.

In addition, when the first layer member **212** of the support member **210** is formed from SiO_2, the SiO_2 layer preferably has a surface roughness Ra of less than **30** nm on the side of the SiO_2 layer that is in contact with the first electrode **234**. When this is done, planarity of the surface of the first layer member **212** on which the capacitor **230** is mounted can be ensured. It is undesirable for the surface on which the orientation control layer **234**A is formed to be rough because the orientation of the crystals will be disrupted during crystal growth by the unevenness of the rough surface.

In this embodiment, the first plug **216** is in a position that is not opposite the first region **234-1** in which the capacitor **230** is formed, and the first layer member **212** therefore has no influence on the planarity of the surface on which the capacitor **230** is mounted. Thus, the orientation of the capacitor **230** is maintained.

The thermal conductivity of the constituent material of the first wiring layer **214** in the region of contact with the first plug **216** provided to the support member **210** can be lower than the thermal conductivity of the constituent material of the first electrode **234** in the region of contact with the first plug **216**. For example, the first wiring layer **214** may have a lower layer that is titanium (Ti) and an upper layer that is titanium nitride (TiN).

When this is done, the thermal conductivity of the titanium nitride (TiN) which is the constituent material of the first wiring layer **214** in the region of contact with the first plug **216** provided to the support member **210** can be lower than the thermal conductivity of the iridium (Ir) which is the constituent material of the first electrode **234** in the region of contact with the first plug **216**. This is due to the fact that the thermal conductivity of titanium (Ti) is 21.9 (W/m·K), which is substantially less than the thermal conductivity of 147 (W/m·K) for iridium (Ir), and the thermal conductivity of the titanium nitride (TiN) is additionally decreased depending on the mixing ratio of nitrogen and titanium.

When the constituent material of the first electrode **234** in the region of contact with the first plug **216** is a binding layer, e.g., titanium aluminum nitride (TiAlN), it is desirable to adjust the mixing ratio of nitrogen and titanium so that the thermal conductivity of the titanium nitride (TiN) which is the constituent material of the first wiring layer **214** in the region of contact with the first plug **216** is lower than the thermal conductivity of the titanium aluminum nitride (TiAlN).

The IrO_x layer **234**B that functions as a reducing gas barrier layer in the first electrode **234** is used in conjunction with the second layer member (e.g., Si_3N_4) **213** of the support member **210** that manifests reducing gas barrier properties and the etching stop layer (e.g., Al_2O_3) **140** of the support member **210** in order to isolate the pyroelectric body **232** from reducing impediment factors that enter from below the capacitor **230**. For example, gas that is released from the substrate **100** during firing of the pyroelectric body (ceramic) **232** and other annealing steps, and reducing gas that is used in the isotropic etching step for the sacrificial layer **150** function as reducing impediment factors.

During the firing step for the pyroelectric body **232**, evaporated gas is generated in some cases inside the capacitor **230** during high-temperature treatment, but an escape route for this evaporated gas is ensured by the first layer member **212** of the support member **210**. In other words, in order for the evaporated gas that is generated inside the capacitor **230** to escape, it is desirable to provide gas barrier properties in the second layer member **213** and to not provide gas barrier properties in the first layer member **212**.

In addition, the IrO_x layer **234**B itself has little crystallinity, but has favorable compatibility with the Ir layer **234**A due to the metal-metal oxide relationship, and the layer thus can have the same preferred orientation system as the Ir layer **234**A.

The Pt layer **234**C that functions as a seed layer in the first electrode **234** has a (111) orientation and serves as a seed layer for preferential orientation of the pyroelectric body **232**. In this embodiment, the Pt layer **234**C is formed with a double-layer structure. The first Pt layer serves as a foundation for the (111) orientation, and the second Pt layer provides micro-roughness at the surface and functions as a seed layer for preferential orientation of the pyroelectric body **232**. The pyroelectric body **232** is thus made to have a (111) orientation in alignment with the seed layer **234**C.

The first electrode **234** has a metal oxide layer **234**B between the two metal layers **234**A, **234**C. For this reason, the amount of heat that is released from the first electrode **234** to the first plug **216** and the first wiring layer **214** can be reduced due to the metal oxide layer **234**B that has lower thermal conductivity than the metal layers **234**A, **234**C. It is thus possible to ensure thermal isolation of the pyroelectric-type detection element **220**.

6.2. Second Electrode Structure

With the second electrode **236**, if filming is carried out using a sputtering method, then the interface will be physically rough, and there is the danger that characteristics will deteriorate as a result of the generation of trap sites. Consequently, reconstruction of crystal-level lattice matching is carried out in order to produce a continuous crystal orientation in the first electrode **234**, the pyroelectric body **232**, and the second electrode **236**.

Although the Pt layer **236**A of the second electrode **236** is formed by sputtering, the crystal orientation of the interface immediately after sputtering is not continuous. Thus, the Pt layer **236**A is recrystallized by carrying out a subsequent annealing treatment. In other words, the Pt layer **236**A functions as an orientation matching layer, and the crystal orientation is made to match that of the pyroelectric body **232**.

The IrO_x layer **236**B in the second electrode **236** functions as a barrier to reducing impediment factors that enter from above the capacitor **230**. In addition, the Ir layer **236**C in the second electrode **236** has a higher resistance than the IrO_x layer **236**B, and so it is used in order to lower the resistance with respect to the plug **228**. The Ir layer **236**C has favorable compatibility with the IrO_x layer **236**B due to the metal oxide-metal relationship and has the same preferential orientation system as the IrO_x layer **236**B.

Thus, in this embodiment, the first and second electrodes **234**, **236** are disposed in multiple layers of Pt, IrOx, and Ir in the stated order relative to the pyroelectric body **232**, the forming materials being arranged symmetrically about the pyroelectric body **232**.

However, the thicknesses of the respective layers of the multilayer structures that form the first and second electrodes **234**, **236** are asymmetrical about the pyroelectric body **232**.

7. Modification Examples

7.1. First Modification Example

As shown in FIG. **5**, the first hole **215** is at a position that faces the first electrode **234** and the first wiring layer **214** and may be formed through to the first layer member **212** at a position that is opposite the capacitor **230**. The first plug **216** is embedded in the first hole **215** that is formed in a position that is opposite the capacitor **230**.

In FIG. **5**, a material such as tungsten (W) having high step coverage (step filmability) is preferably used for the first plug **216** The first surface **211**A of the support member **210** affects the orientation of the capacitor **230**, and thus planarity is desired.

In this embodiment as well, the wiring that connects to the first electrode **234** can be formed by the first wiring layer **214** and the first plug **216** formed on the support member **210**. The first plug **216** is formed on the support member **210** at a position that is opposite the capacitor **230**, and thus the element surface area is not any larger than in FIG. **1** due to the wiring that connects to the first electrode **234**. A pyroelectric detector thus can be offered that is suitable for producing high levels of integration.

In FIG. **5**, the wiring structure in the post **104** is exactly the same as in FIG. **1**, and so the depth D of the cavity part **102** shown in FIG. **1** can be ensured at about 2 μm, allowing reliable thermal isolation of the thermal detection element **220**.

7.2. Second Modification Example

In FIG. **6**, in contrast to FIGS. **1** and **5**, the first and second wiring layers **214**, **217** that respectively connect with the first and second electrodes **234**, **236** are not provided on the support member **210**. Rather, the first and second electrode wiring layers **222**, **224** that connect respectively with the first and second electrodes **234**, **236** are provided on the interlayer insulating layer **250**.

An intermediary conductive layer **238** is formed on the first surface **211**A in the substrate member **210** on the post **104** shown in FIG. **6**. The interlayer insulating layer **250** is formed so that it covers the intermediary conductive layer **238**. The second electrode wiring layer **222** is formed on the interlayer insulating layer **250**. The second electrode wiring layer **222** is in continuity with the intermediary conductive layer **238**. In the structure of FIG. **6**, the step shape shown in FIG. **3** is formed in the arm part of the support member **210**.

In addition, in FIG. **6**, the intermediary conductive layer **238** is formed on the arm part **210**B of the support member **210** (refer to FIG. **2**).

In the example of FIG. **6**, the intermediary conductive layer **238** that is defined as the third conductive layer is not buried in the support member **210**, but is exposed on the first surface **211**A. In this case, as shown in FIG. **6**, the metal wiring layer on the silicon substrate **110** is taken to be four layers, and the two metal layers LIC, LID are apportioned to the second conductive layer in the post **104**. In this manner, the depth D of the cavity part **102** can be ensured at about 2 μm.

FIG. **6** shows an example of dimensions that ensure that the depth D of the cavity part **102** is 2 μm. For example, taking the lengths of the plugs HLB, HLC, HLD as 1 μm, and taking the thicknesses of the second conductive layers LIC, LID as 0.2 μm, the distance L between the third conductive layer **238** and the first conductive layer LIB will be 3.4 μm.

The total thickness T**1** of the support member **210** and the etching stop layer **140**, and the margin thickness T**2** from the bottom part of the cavity part **102** to the first conductive layer LIB, from FIG. **1**, are as follows: D=L−T**1**−T**2**=3.4−T**1**−T**2**=2 μm. It is thus ensured that T**1**+T**2** is 1.4 μm. By decreasing the wiring formation hurdle in the post **104** in this manner, it is possible to ensure that the depth D of the cavity part **102** that allows thermal isolation is about 2 μm, which is the same as in FIGS. **1** and **5**. On the other hand, when one second conductive layer LIC is disposed in the post **104** in FIG. **6**, only T**1**+T**2**=0.2 μm can be ensured, and thus it is not possible to ensure even the thickness of the support member **210**.

8. Electronic Instrument

8.1. Infrared Camera

FIG. **7** shows a configuration example for an infrared camera **400**A which is used as an example of an electronic instrument that comprises the thermal detector or thermal detection device of this embodiment. This infrared camera **400**A comprises an optical system **400**, a sensor device (thermal detection device) **410**, an image processing part **420**, a processing part **430**, a storage part **440**, an operating part **450**, and a display part **460**. The infrared camera **400**A of this embodiment is not restricted to the configuration of FIG. **7**, and various modified embodiments are possible in which some of the constituent elements (e.g., the optical system, operating part, or display part) are omitted and other constituent elements are added.

The optical system **400** comprises, for example, one or a plurality of lenses and a drive part or the like that drives these lenses. Image capture of the image of an object is carried out by the sensor device **410**, and focal adjustment is carried out as necessary.

The sensor device **410** has a configuration in which thermal detectors **200** of the embodiments described above are arranged two-dimensionally, and a plurality of lines (scan lines or word lines) and a plurality of columns (data lines) are provided. The sensor device **410** can also comprise row selection circuits (row drivers), a read circuit for reading data from the detectors via the columns, an A/D converter, and the like, in addition to the detectors that are arranged two-dimensionally. Because data is sequentially read from detectors that are arranged two-dimensionally, a captured image of the subject can be processed.

Based on the digital image data (pixel data) from the sensor device **410**, the image processing part **420** carries out various image processing operations such as image correction processing.

The processing part **430** carries out control of the respective elements of the infrared camera **400**A and overall control of the infrared camera **400**A. The processing part **430** is realized, for example, in a CPU or the like. The storage part **440** stores various types of information, and, for example, functions as a work space for the processing part **430** or the image processing part **420**. The operating part **450** is used as an interface for a user to operate the infrared camera **400**A and can be realized, for example, in the form of various buttons, a graphical user interface (GUI) screen, or the like. The display part **460** displays the GUI screen, images that have been captured by the sensor device **410**, and the like, and is realized in the form of various types of displays, such as a liquid crystal display or organic EL display.

A sensor device **410** can be configured by using the thermal detector of a single cell as a sensor such as an infrared sensor in this manner, and, by disposing the thermal detector of each cell two-dimensionally along two axes, e.g., two perpendicular axes. When this is done, it is possible to capture thermal (light) distribution images. By using this sensor device **410**, it is possible to configure an electronic instrument such as a thermographic device or an on-board automotive night-vision or surveillance camera.

As shall be apparent, using the thermal detector of one cell or a plurality of cells as a sensor, it is possible to configure various types of electronic instruments, such as analytical instruments (measurement instruments) for analyzing (measuring) physical data related to an object, security instruments for detecting fire or heat, and factory automation (FA) instruments that are installed in factories and the like.

8.2. On-Board Assistance Device

FIG. **8** shows a configuration example of an on-board assistance device **600** that is an example of an electronic instrument that comprises the pyroelectric detector or pyroelectric detection device of this embodiment. The on-board assistance device **600** has a configuration that comprises a processing unit **610** having a CPU that controls the on-board assistance device **600**, an infrared camera **620** that allows detection of infrared light in a prescribed imaging region outside the automobile, a yaw rate sensor **630** that detects the automobile yaw rate, a speed sensor **640** that detects the travel speed of the automobile, a brake sensor **650** that detects operation of the brake by the driver, a speaker **660**, and a display device **670**.

The processing unit **610** of the on-board assistance device **600** detects an object such as a pedestrian or a body that is present in advance of the travel direction of the automobile from infrared images of the periphery of the automobile obtained by imaging using the infrared camera **620**, and detection signals related to the state of travel of the automobile that are detected by the respective sensors **630** to **650**. When it is determined that contact between the automobile and a detected object may occur, a warning is output by the speaker **660** or the display device **670**.

For example, as shown in FIG. **9**, the infrared camera **620** is disposed near the middle of the vehicle width direction along the front of the automobile. The display device **670** is configured by providing a heads-up display (HUD) **671** that displays various data in a position in the front window that does not obstruct the frontward field of view of the operator.

8.3. Security Instrument

FIG. **10** shows a configurational example of a security instrument **700** which is used as an example of an electronic instrument that comprises the pyroelectric detector or pyroelectric detection device of this embodiment.

The security instrument **700** comprises an infrared camera **710** that takes images of at least an area to be monitored, a human sensor **720** that detects intruders into the monitored area, a detection processing part **730** that acts to detect moving bodies that enter into the monitored area by processing image data that is output from the infrared camera **710**, a human sensor detection processing part **740** that carries out detection processing for the human sensor **720**, an image compression part **750** that compresses image data that has been output from the infrared camera **710** into a prescribed format, a communication processing part **760** that transmits compressed image data or intruder detection data and receives various types of setting information for the security instrument **700** from external devices, and a control part **770** that uses a CPU to carry out parameter setting, processing command transmission, and response processing with respect to various processing parts of the security instrument **700**.

The motion detection processing part **730** has a buffer memory that is not shown in the drawings, a block data smoothing part whereby the output of the buffer memory is input, and a state modification detection part whereby the output of the block data smoothing part is input. The state modification detection part of the movement detection processing part **730** detects a change in state using the fact that the same image data will be present in different frames taken in movie mode if the monitored area is under static conditions, whereas a difference in image data between frames will arise when a change of state occurs (entry of a moving body).

FIG. **11** is a side view of a security instrument **700** that is installed, e.g., under a roof overhang, an imaging area A**1** of the infrared camera **710** that is contained in the security instrument **700**, and a detection area A**2** of the human sensor **720**.

8.4. Gaming Device

FIGS. **12** and **13** show an example of the configuration of a gaming device **800** that contains a controller **820** that utilizes the sensor device **410** described above, which is used as an example of an electronic instrument that contains the pyroelectric detector or pyroelectric detection device of this embodiment.

As shown in FIG. **12**, the controller **820** that is used in the gaming device **800** of FIG. **13** has a configuration that comprises an image data computation unit **830**, an operating switch **840**, an acceleration sensor **850**, a connector **860**, a processor **870**, and a wireless module **880**.

The imaging data computation unit **830** has an image capture unit **831** and an image processing circuit **835** for processing the image data that has been captured by the image capture unit **831**. The image capture unit **831** includes a sensor device **832** (sensor device **410** of FIG. **7**), there being an infrared filter **833** (that admits only infrared light) and an optical system (lens) **834** disposed in front thereofThe image processing circuit **835** processes the infrared image data obtained from the image capture unit **831**, detects high-brightness portions, detects the centers of gravity and the surface areas thereof, and then outputs these data.

The processor **870** outputs, as a series of control data, operational data obtained from the operating switch **840** and acceleration data obtained from the acceleration sensor **850**, as well as high-brightness data. The wireless module **880** modulates a carrier signal of a prescribed frequency with the control data and outputs a signal from the antenna **890** as a radio signal.

The data that has been input through the connector **860** that is provided on the controller **820** is processed by the processor **870** in the same manner as the data described above and is output via the wireless module **880** and the antenna **890** as control data.

As shown in FIG. **13**, the gaming device **800** has a controller **820**, a gaming device main unit **810**, a display **811**, and LED modules **812**A and **812**B. A player **801** can use one hand to grasp the controller **820** to play the game. When the image capture unit **831** of the controller **820** is facing a screen **813** of the display **811**, infrared light that is output from the two LED modules **812**A, **812**B that are disposed near the display **811** is detected by the image capture unit **831**, and the controller **820** acquires surface area and position information of the two LED modules **812**A, **812**B as high-brightness point information. Data concerning the positions and sizes of the bright points is transmitted wirelessly from the controller **820** to the gaming device main unit **810** and is received by the gaming device main unit **810**. When the player **801** moves the controller **820**, the position and size data of the bright points change, and this change is used in order to allow the gaming device main unit **810** to acquire operational signals corresponding to movement of the controller **820**, thereby allowing gaming to progress.

8.5. Body Temperature Measurement Device

FIG. **14** shows an example of the configuration of a body temperature measurement device **900**, which is used as an example of the electronic instrument that contains the pyroelectric detector or pyroelectric detection device of this embodiment.

As shown in FIG. **14**, the body temperature measurement device **900** has a configuration that comprises an infrared camera **910**, a body temperature analysis device **920**, an information notification device **930**, and a cable **940**. The infrared camera **910** has a configuration that comprises an optical system such as a lens (not shown), and the aforementioned sensor device **410**.

The infrared camera **910** images a predetermined target region, and image data related to the subject whose image has been captured is transmitted to the body temperature analysis device **920** via the cable **940**. The body temperature analysis device **920** (not shown) comprises an image reading processing unit that reads the heat distribution image from the infrared camera **910**, and a body temperature analysis unit that generates a body temperature analysis table based on an image analysis settings table together with data from the image reading processing unit; and transmits body temperature transmission data based on the body temperature analysis table to the information notification device **930**. This body temperature transmission data may also include prescribed data for when the body temperature is abnormal. When it is determined that a plurality of subjects are in the image capture region, the body temperature transmission data also includes information concerning the number of subjects and the number of persons having an abnormal body temperature.

8.6. Specified Substance Searching Device

FIG. **15** shows an example of the configuration of a specified substance searching device **1000** that combines a terahertz illumination unit along with a terahertz light sensor device in the form of a sensor device having a terahertz range for the absorption wavelengths of the light-absorbing material of the pyroelectric detector of the sensor device **410** described above. This device is used as an example of an electronic device that contains a pyroelectric detector or pyroelectric detection device of this embodiment.

The specified substance searching device **1000** has a configuration that comprises a control unit **1010**, an illumination unit **1020**, an optical filter **1030**, an image capture unit **1040**, and a display part **1050**. The image capture unit **1040** has a configuration that comprises an optical system such as a lens, and a sensor device having a terahertz absorption wavelength range for the light-absorbing material of the aforementioned pyroelectric detector (neither of which being shown in the drawing).

The control unit **1010** includes a system controller, where the system controller controls the entire device and controls an image processing unit and a light source drive part included in the control unit. The illumination unit **1020** includes an optical system and a laser device that emits terahertz light (electromagnetic radiation in the wavelength range of 100 to 1000 μm), thereby illuminating a person **1060** who is the subject of inspection with terahertz light. The reflected terahertz light from the person **1060** is received by the image capture unit **1040** via the optical filter **1030** that allows only light in the spectrum of a specified substance **1070** that is the target of investigation to pass through. The image signal that is generated by the image capture unit **1040** is subjected to prescribed image processing by the image processing unit of the control unit **1010**, and the image signal is output to the display part **1050**. The presence of the specified substance **1070** can be determined depending on the intensity of the received light signals which differ depending on whether the specified substance **1070** is present in the clothing or the like of the person **1060**.

A number of embodiments of electronic instruments were described above, but the electronic instruments of the embodiments described above are not restricted by the configurations that have been presented, and various modifications may be implemented that involve elimination of some of the constituent elements (e.g., optical system, operating part, display part) and addition of other constituent elements.

9. Sensor Device

An example of the configuration of the sensor device **410** of FIG. **7** is shown in FIG. **16**A. This sensor device comprises a sensor array **500**, a row selection circuit (row driver) **510**, and a read circuit **520**. The device may also comprise an A/D conversion part **530** and a control circuit **550**. The row selection circuit (row driver) **510** and the read circuit **520** are referred to as the "driver circuit." As shown in FIG. **7**, this sensor device can be used to realize an infrared camera **400**A that is used, for example, in a navigation device.

In the sensor array **500**, a plurality of sensor cells are arranged (disposed) along two axes as shown, for example, in FIG. **2**. A plurality of rows (word lines, scan lines) and a plurality of columns (data lines) are also provided. The number of either the rows or columns may also be one. For example, when the number of rows is one, a plurality of sensor cells are arranged along the row direction (horizontal direction) in FIG. **16**A. On the other hand, when the number of columns is one, a plurality of sensor cells is arranged in the column direction (vertical direction).

As shown in FIG. **16**B, each of the sensor cells of the sensor array **500** is disposed (formed) at a location corresponding to the intersection position of a row and a column. With the sensor cell shown in FIG. **16**B, the cell is disposed at a location corresponding to the intersection of the row WL**1** and the column DL**1**. The other sensor cells are similar.

The row selection circuit **510** is connected to one or a plurality of rows and carries out the selection operation for each row. For example, taking the sensor array **500** (focal plan array) of a QVGA (320×240 pixels) device shown in FIG. **8**(B) as an example, operation is carried out by the sequential selection (scanning) of rows WL**0**, WL**1**, WL**2**, . . . WL**239**. Specifically, signals for selecting these rows (word selection signals) are output to the sensor array **500**.

The read circuit **520** is connected to one or a plurality of columns. Read operations are thereby carried out on respective columns. Taking the QVGA sensor array **500** as an example, a read operation is carried out on the detection signals (detected current, detected charge) from the columns DL**0**, DL**1**, DL**2**, . . . DL**319**.

The A/D conversion part **530** carries out processing whereby the detected voltage (measured voltage, attained voltage) acquired by the read circuit **520** is subjected to A/D conversion to produce digital data. Digital data DOUT is thus output after A/D conversion. Specifically, respective A/D converters corresponding to each column of the plurality of columns are provided in the A/D conversion part **530**. The respective A/D converters carry out A/D conversion on the detected voltages that have been acquired by the read circuit **520** for the corresponding columns. A single A/D converter may also be provided for a plurality of columns, and the detected voltages for the plurality of columns may be subjected to time-division A/D conversion using this single A/D converter.

The control circuit **550** (timing generation circuit) generates various types of control signals which are output to the row selection circuit **510**, the read circuit **520**, and the A/D conversion part **530**. For example, a charge or discharge (reset) control signal is generated and output. Alternatively, a signal that controls the timing for each of the circuits is generated and output.

While only selected embodiments have been described, it will be readily apparent to those skilled in the art from the novel matters and effects of the present invention that numerous modifications may be made herein without substantially departing from the scope of the invention. Consequently, all modifications such as the above may be understood to fall within the scope of the invention. Terms disclosed together with different equivalent or broader terms in at least one instance in the specification or drawings, for example, may be replaced by these different terms at any place in the specification or drawings.

The present invention can be widely utilized in various types of thermal detectors (e.g., thermopile elements (thermopiles), pyroelectric-type elements, and bolometers) without concern regarding the wavelength of the light that is to be detected. In addition, thermal detectors or thermal detection devices, or electronic instruments that contain them, for example, may be utilized in flow sensors and the like for detecting the flow rate of fluids under conditions in which there is equilibrium between the heat that is given off and the heat that is taken in by the fluid. The thermal detector or thermal detection device of the present invention may be provided instead of a thermocouple or the like in the flow sensor, and the subject of detection can thus be something other than light.

GENERAL INTERPRETATION OF TERMS

In understanding the scope of the present invention, the term "comprising" and its derivatives, as used herein, are intended to be open ended terms that specify the presence of the stated features, elements, components, groups, integers, and/or steps, but do not exclude the presence of other unstated features, elements, components, groups, integers and/or steps. The foregoing also applies to words having similar meanings such as the terms, "including", "having" and their derivatives. Also, the terms "part," "section," "portion," "member" or "element" when used in the singular can have the dual meaning of a single part or a plurality of parts. Also as used herein to describe the above embodiments, the following directional terms "top", "bottom", "upper", "lower", "forward", "rearward", "above", "downward", "vertical", "horizontal", "below" and "transverse" as well as any other similar directional terms refer to those directions of the thermal detector when the thermal detector is oriented as shown in FIG. **1**. Finally, terms of degree such as "substantially", "about" and "approximately" as used herein mean a reasonable amount of deviation of the modified term such that the end result is not significantly changed. For example, these terms can be construed as including a deviation of at least ±5% of the modified term if this deviation would not negate the meaning of the word it modifies.

While only selected embodiments have been chosen to illustrate the present invention, it will be apparent to those skilled in the art from this disclosure that various changes and modifications can be made herein without departing from the scope of the invention as defined in the appended claims. Furthermore, the foregoing descriptions of the embodiments according to the present invention are provided for illustration only, and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

What is claimed is:

1. A thermal detector comprising:
a substrate;
a support member having a first surface and a second surface opposite from the first surface;
a spacer member connected to the substrate and supporting the support member so that a cavity part is formed between the substrate and the second surface of the support member;
a thermal detection element supported on the first surface of the support member;
a detection circuit disposed in the substrate and connected to the thermal detection element; and
a wiring part connecting the thermal detection element and the detection circuit, the wiring part having
a first conductive layer part including at least one layer disposed in the substrate,
a second conductive layer part including at least one layer disposed in the spacer member,
a third conductive layer part including at least one layer supported by the support member, and
a plurality of plugs respectively connecting adjacent layers of the first conductive layer part, the second conductive layer part and the third conductive layer part, in a thickness direction of the substrate.

2. The thermal detector according to claim **1**, wherein
the at least one layer of the third conductive layer part is disposed in the support member at a position that is not exposed on the first surface of the support member.

3. The thermal detector according to claim **1**, wherein
the second conductive layer part includes only one layer.

4. The thermal detector according to claim **1**, wherein
each of a thermal conductivity of the at least one layer of the first conductive layer part and a thermal conductivity of the at least one layer of the second conductive layer part is less than a thermal conductivity of each of the plugs.

5. The thermal detector according to claim **1**, wherein
the thermal detection element includes a first electrode mounted on the support member, a second electrode opposed to the first electrode, and a pyroelectric body disposed between the first and second electrodes, with the first electrode including a first region on which the pyroelectric body is layered, and a second region protruding from the first region in plan view, and
the support member has an insulating layer with the at least one layer of the third conductive layer being disposed on a side of the second surface of the support member with respect to the insulating layer, and a first plug passing through the insulating layer at a position where the second region of the first electrode and the at least one layer of the third conductive layer part overlap in plan view to connect the second region of the first electrode with the at least one layer of the third conductive layer part.

6. The thermal detector according to claim **1**, wherein
the thermal detection element includes a first electrode mounted on the support member, a second electrode opposed to the first electrode, and a pyroelectric body disposed between the first and second electrodes, and
the support member has an insulating layer with the at least one layer of the third conductive layer being disposed on a side of the second surface of the support member with respect to the insulating layer, and a first plug passing through the insulating layer at a position where the pyroelectric body and the at least one layer of the third conductive layer part overlap in plan view to connect the first electrode and the at least one layer of the third conductive layer.

7. The thermal detector according to claim **1**, wherein
the thermal detection element is a bolometer in which a resistance value changes depending on a temperature.

8. The thermal detector according to claim **1**, wherein
the at least one layer of the third conductive layer part is disposed on the first surface of the support member.

9. The thermal detector according to claim **8**, wherein
the thermal detection element includes a first electrode mounted on the support member, a second electrode opposed to the first electrode, and a pyroelectric body disposed between the first and second electrodes, with the first electrode including a first region on which the pyroelectric body is layered, and a second region protruding from the first region in plan view,
the at least one layer of the third conductive layer part being connected to the first electrode at a position where the pyroelectric body and the at least one layer of the third conductive layer part overlap in plan view, and
one of the plugs passes through the support member to connect between the at least one layer of the third conductive layer part and the at least one layer of the second conductive layer part.

10. A thermal detection device comprising:
a plurality of the thermal detectors according to claim **1** arranged two-dimensionally along two intersecting axes.

11. A thermal detection device comprising:
a plurality of the thermal detectors according to claim **2** arranged two-dimensionally along two intersecting axes.

12. A thermal detection device comprising:

a plurality of the thermal detectors according to claim 3 arranged two-dimensionally along two intersecting axes.

13. A thermal detection device comprising:

a plurality of the thermal detectors according to claim 4 arranged two-dimensionally along two intersecting axes.

14. A thermal detection device comprising:

a plurality of the thermal detectors according to claim 5 arranged two-dimensionally along two intersecting axes.

15. A thermal detection device comprising:

a plurality of the thermal detectors according to claim 6 arranged two-dimensionally along two intersecting axes.

16. A thermal detection device comprising:

a plurality of the thermal detectors according to claim 7 arranged two-dimensionally along two intersecting axes.

17. An electronic instrument comprising:

the thermal detector according to claim 1.

18. An electronic instrument comprising:

the thermal detector according to claim 2.

19. An electronic instrument comprising:

the thermal detection device according to claim 10.

20. An electronic instrument comprising:

the thermal detection device according to claim 11.

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